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Vol. 43, No. 1, 1960

THE MALAYAN AGRICULTURAL JOURNAL

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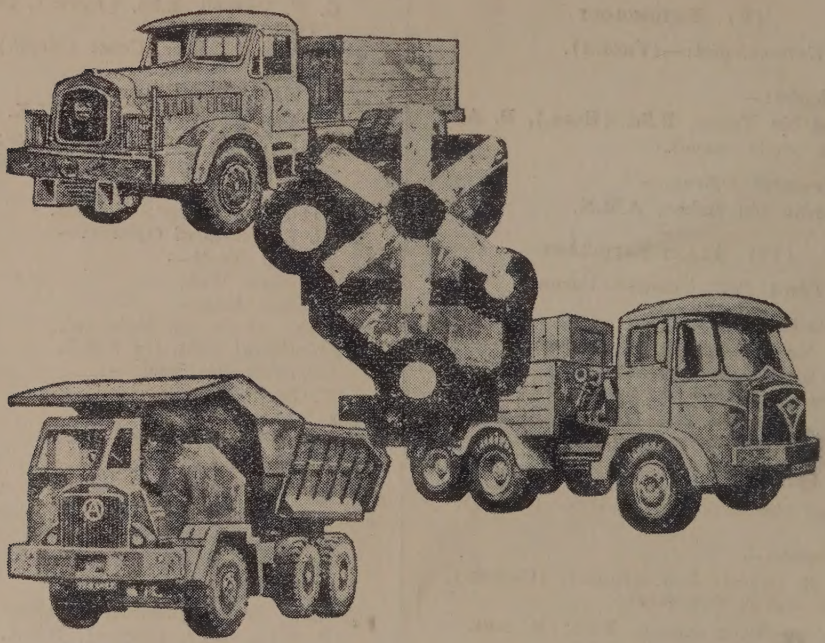

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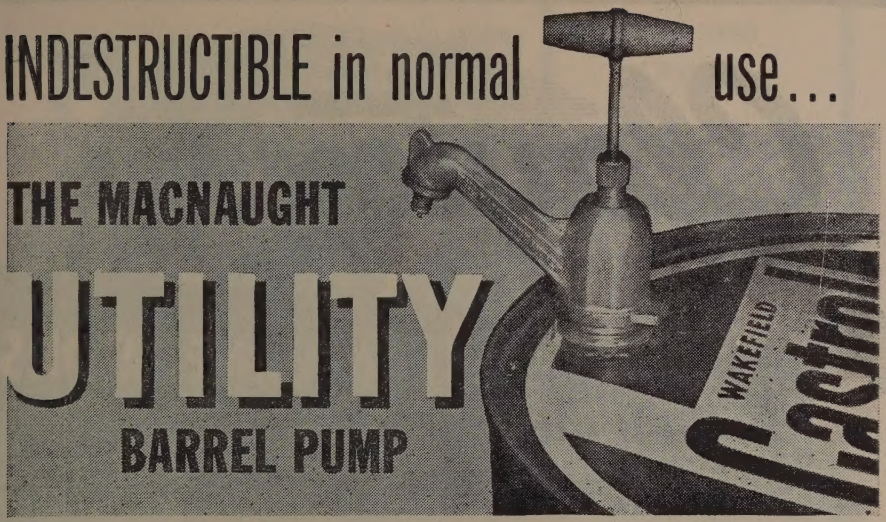

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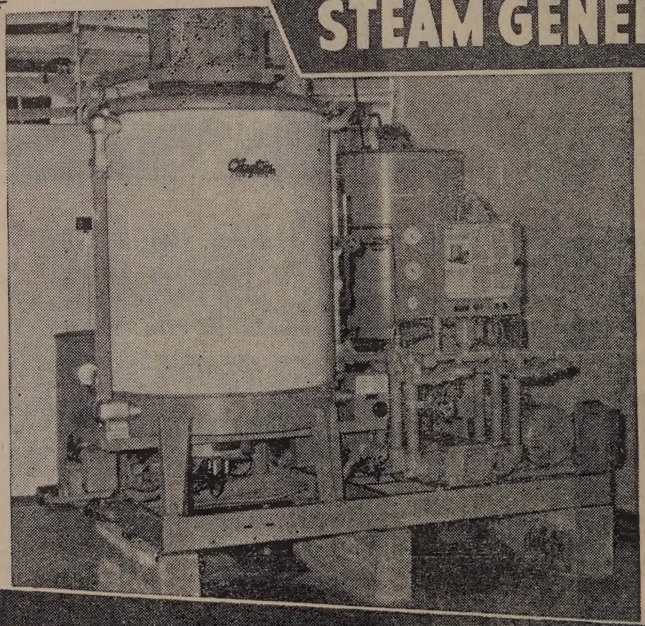

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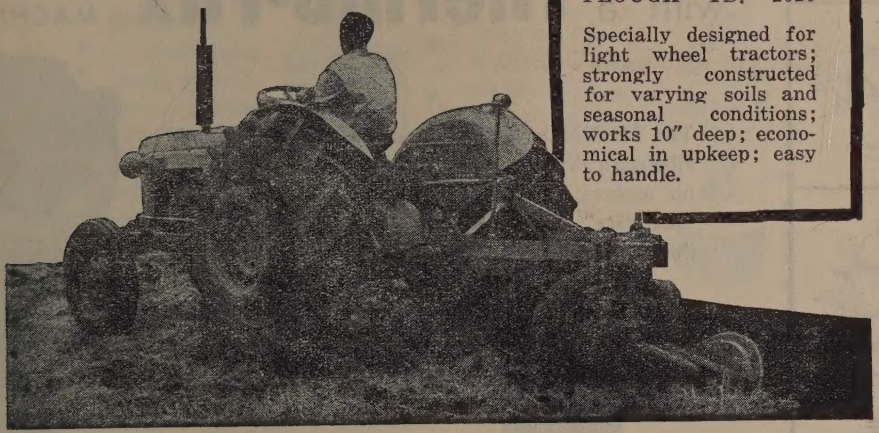

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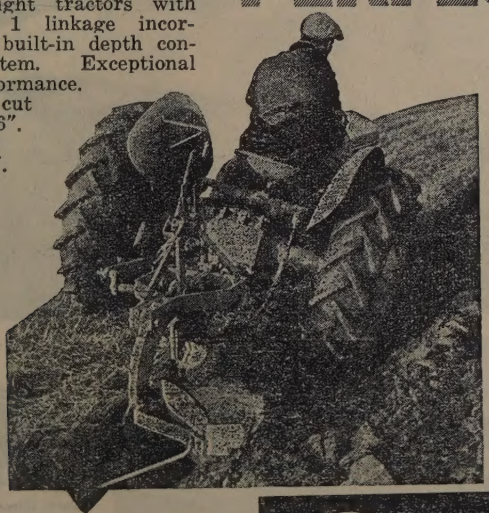

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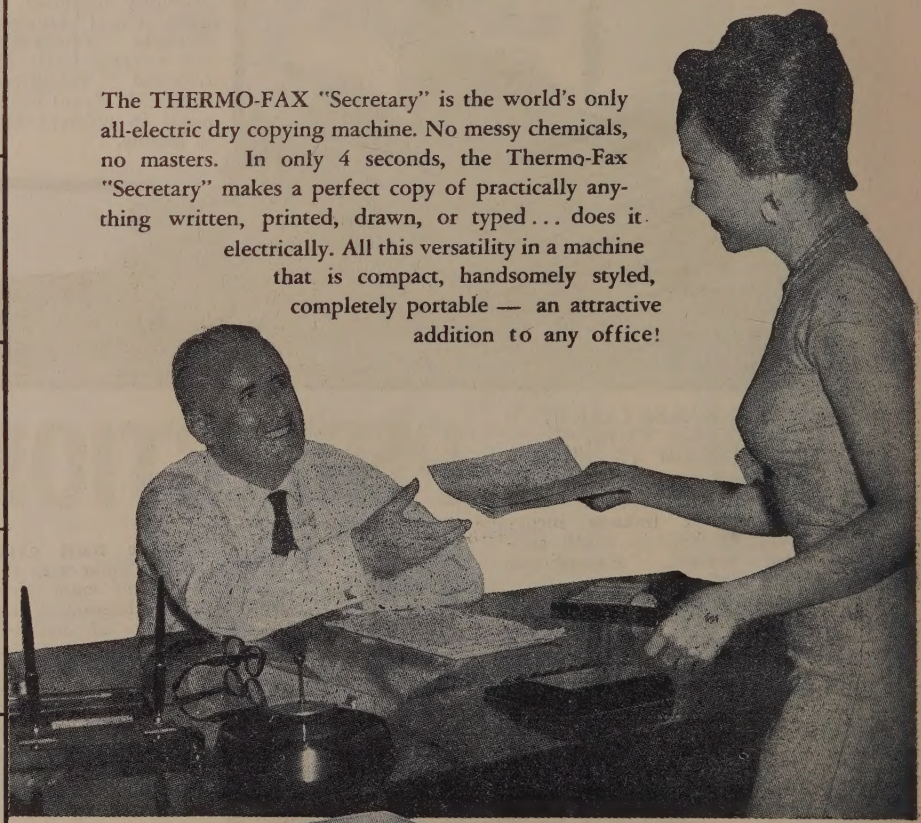

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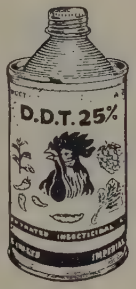

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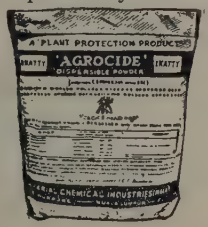

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Corrigendum

MALAYAN AGRICULTURAL JOURNAL
Volume 42, No. 4, 1959

Plates I and II facing page 186.
Caption Plate I, for "seven years old" read "seven months old".

THE

Malayan Agricultural Journal

Edited by the Publications Officer
with the assistance of the Publications Committee.

Vol. 43, No. 1 **1960**

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THE MALAYAN AGRICULTURAL JOURNAL

The Journal is designed to present — as far as possible in non-technical terms — the results of the agricultural research, investigation and extension work performed by the Department of Agriculture and it draws attention to the results of work of a similar nature in other countries.

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THE
Malayan Agricultural Journal
Vol. 43, No. 1, 1960

EDITORIAL

As most of our readers are aware, the 43rd volume of the Malayan Agricultural Journal, of which this is the first issue, will appear over a period of approximately 24 months, instead of 12, as in the past. The continuity of the statistical information will be maintained and it is hoped to return to a quarterly programme of publication in subsequent volumes.

In line with Government policy to promote the National language, Malay, it has been decided to publish an annual volume which will contain translations of the more important articles which have appeared in the Malayan Agricultural Journal in recent years. There are also proposals under discussion to produce a farmers' advisory journal in the National language, but staffing difficulties constitute a major obstacle at present.

A Pest of Cacao. Mrs. Thomas, who is a lecturer at the College of Agriculture, Serdang, has contributed in this issue a detailed study of *Conopia* Sp., which has proved to be an important pest of cacoa at Serdang. Her useful description of the life history of this insect provides a guide to possible methods of control.

Phytophthora palmivora. Readers will recall an article by Mr. Aldworth Thompson on this pest of orchids, which appeared in the Malayan Agricultural Journal Vol. 42, No. 2, 1959. Since then, Mr. Turner of the West African Cacao Research Institute, Ghana, has been working on specimens of the parasite supplied by the University of Malaya and has contributed a short article on the link between this pest and similar parasites which attack rubber and cacao. This joint investigation is an example of the international co-operation which exists in tackling scientific problems, especially between members of the Commonwealth.

Quality Testing of Rice. The production of rice that is satisfactory both to consumers and to members of the trade is discussed by Mr. T. K. Van in this issue. He draws attention to the factors involved in judging the quality of rice grains and describes the various laboratory tests which are made.

Photosensitivity of Rice. Dr. Dore, who has now left the Department, describes a number of experiments that were made to find if any correlation exists between date of maturity, day lengths and time of planting of the rice plant. Although differences in day lengths in Malaya from north to south are slight, his analysis of the data collected suggests the necessity for further work on this subject.

Chinese Grass Carp. A second article on fish culture by Mr. C. F. Hickling, who was formerly Director of the Fish Culture Research Station, Malacca, describes the rapid growth made by Chinese Grass Carp in Malaya. The excellent rate of conversion of Napier grass, which is easily grown on waste ground in Malaya, into fish, should make this type of fish farming an attractive proposition to smallholders. A previous article by the same author on marking experiments with Tilapia fish appeared in Vol. 42, No. 1, of this Journal.

LIFE-HISTORY OF CONOPIA SP. *(AEGERIIDAE : LEPIDOPTERA)* A NEW PEST ON CACAO IN MALAYA, WITH REFERENCE TO DAMAGE DONE

BY

V. THOMAS,

Assistant Lecturer,

College of Agriculture, Serdang.

Introduction

Conopia sp. is one of the more important pests of cacao (*Theobroma cacao*) in Malaya, which occurs in fairly considerable numbers in the cacao fields at Federal Experiment Station, Serdang, about 15 miles south of Kuala Lumpur.

The occurrence of this species was first recorded as a borer in shells of cacao pods in Malaya in 1910, by Doctor Van Leeuwen (cited by Dammerman) (1) who described it as boring into pods that had been turned hard and black on account of attack by *Helopeltis* or into diseased wood of cacao. The damage caused was insignificant. Miller (3) in his paper on "Insects associated with Cacao in Malaya", did not make any mention of this insect. It was first recognized as a pest in 1955 when it was found in abundance in the cacao fields at Serdang attacking a large number of trees. Today *Conopia* is one of the more important pests of cacao at Serdang. *Conopia* is found to attack pods infested by *Helopeltis* as well as healthy pods and stems, but they seldom or never attack pods which are turned fully black and hard by *Helopeltis* attack, or diseased wood. The injury caused to cacao when this pest is abundant is often serious.

Losses due to this borer are heavy and attempts at control, so far, have consisted of such measures as removal of heavily infested pods, cleaning affected parts of the stems, applying dieldrex, and then covering the affected portion with tar. It was decided to investigate possible methods of direct insecticidal treatment against this pest whose life-history was little known. Therefore a critical study of its life-history appeared to be an essential pre-requisite for achieving this end.

Material and Method

In the first instance different instar larvae and eggs of *Conopia* were collected from cacao fields, Federal Experiment Station, Serdang, for rearing. The larvae were taken out of the infested pods, and kept in small 8 cm x 3 cm pieces of freshly cut outer wall of fully grown pods. Each piece was provided with a shallow groove 2 cm x .75 cm where a single larva was introduced and covered with slightly smaller

piece of pod provided with a similar groove. These allowed the larvae a feeling of protection and prevented the rapid drying of cut pieces of pod. The larvae were then kept in shallow glass troughs which were covered with wire gauze. The caterpillars were allowed to feed undisturbed for two to three days, after which they were transferred to fresh pieces of shells of cacao.

Healthy caterpillars tunneled completely into the pods a few hours after release. Before pupation, the mature larvae made an exit hole and prepupated near its mouth. Pupation occured later and the pupae were collected every three days, and placed in different labelled small cages. As adults emerged the date of emergence and sex were recorded, they were then released into a 3′ x 3′ x 3′ cage made of wire gauze. The floor of the cages was made of zinc. High humidity was maintained inside the cage by spreading wet soil to a thickness of one and a half inches and covering it with moist dry leaves of cacao in layers. Water was sprinkled thrice a day to keep the soil and leaves moist.

Fully developed healthy and infested pods and pieces of stem of cacao were placed inside the cage to find out the insects' preference for oviposition. These were examined daily for eggs and were renewed every four days.

Field collected eggs were most satisfactory for rearing. Eggs were abundant in the fields on infested pods and stems. These eggs were carefully removed with a sharp scalpel and placed in shallow petri dishes containing moistened crumpled lens paper. Small holes 1 cm in diameter were bored in parallel rows to a depth of 0.75 cm. in rectangular blocks of ordinary parafin wax. The top surface was smoothed for close fitting of microscope slides. A small piece of fresh shell was placed in each cell and an egg was placed in its natural position on the cube as described by Howe(2). This allows observation of hatching of the larvae very clearly. After hatching the first instar larvae bored into the pod shell. The cubes were removed every three to four days.

Though extreme care was taken while handling these earlier instar larvae for transfer to new pieces of pod and subsequent examination, most of these were either injured or dead and only a very few could be reared in the laboratory.

As it was difficult to rear the larvae under laboratory conditions, observation on the length of larvae life was made in the field. Newly hatched larvae were transferred to unaffected healthy pods in the field. These pods were then covered by thin muslin cloth to prevent any other adults ovipositing on them. Weekly observations were made for the first four weeks and then daily observations were made for any prepupae or pupae near the exit holes and any found were recorded and transferred to the laboratory. Due to their minute size during the first and second instars and tunnelling habits, it was extremely difficult to find out the number of moults and instars in the larval life.

Life History

Description and Habits

Adults:

Adults are small, active, clear-wing moths which on the wing are readily mistaken for wasps. They are about 1 to 1.2 cm. long execlusive of the antennae and have a wing expansion of 1.8 to 2 cm. The body is metalic blue in colour with shining yellow bands. Tips of the abdomen bear a brush-like tuft consisting of flattened yellow and black scales. These tufts are large and fan-like in males but smaller in females; they are moveable and at times the brushes are held above the body level and slowly waved in a circular manner.

Females:

Females (Fig. I) have thicker abdomen than the males, with short brushes and five or six prominent orange or yellow bands around the abdomen. At the posterior margin of the thorax is another very prominent band which bears along its lateral margine two prominent yellow lines of scales. Both pairs of wings, except the margins, are clear, unlike those of female peach tree borer *Conopia exitiosa* Say (Snapp) (4) and *Sanninoidea exitiosa* Say (Snapp(5)) and Snapp Thomson) (6) in which the forewings are opaque. The scales on the underside of the body are predominently yellowish.

Males:

The males (Fig. II) are darker in colour with slender abdomen and a larger tuft of brushes, which are very prominent and fan-like. The yellow bands around the abdomen are not very broad and prominent as in the females. Both pairs of wings are clear, except margins. Males are faster fliers.

The antennae in both sexes are slender and filiform ending in a small tuft of hairs.

The adults are day fliers and are very active on clear and sunny days. Captive adults are always seen resting only on that side of the cage which receives the most amount of light. It is doubtful whether the moths feed, but in a few cases, moths were found resting on wicks soaked in dilute sugar solution, with their proboscis fully drawn out.

Egg laying begins from a few hours up to a day after emergence. (Table I). As the females are very sensitive to the slightest changes in the environmental conditions, only a few females oviposited under laboratory conditions. Both under natural and laboratory conditions, adults prefer, for ovipositions, pods and regions of stems previously attacked either by *Helopeltis* or by an older generation of *Conopia*. The eggs are deposited singly or in small clusters of three or four among frass near the mouths of tunnels made by older larvae or in tiny cracks on small thickened areas on the surface of pods formed as a result of

Helopeltis attack. This habit of laying the eggs among the frass near the mouth of previous tunnels and in small cracks on pods and stems probably gives protection to the eggs and newly hatched larvae from parasites. The previously affected spots also present weak surfaces for the penetration of the first instar larvae.

A single female lays about 250 to 300 eggs scattered on the surface of several pods or at different places on the bark of one or more trees. It can oviposit for a period of two to four days (Table II). Oviposition generally occurs during day time. Most of the caged adults live between three to seven days (Table I).

Table I

Oviposition and Longevity of Females in the Insectary.

No. observed	Date of Emergence	Date of Oviposition		Length of oviposition (in days)	Total No. of eggs	Adults died		Length of Adult life (in days)	Eggs in Average body after death
		first	last			first	last		
5	21.5.58	21.5.58	24.5.58	2—3	275	24/5	27/5	3—6	56
7	1.6.58	2.6.58	5.6.58	2—3	255	5/6	7/6	4—6	67
6	2.8.58	2.8.58	6.8.59	2—4	300	6/8	9/8	4—7	59
10	15.9.58	16.9.58	20.9.59	2—4	289	18/9	22/9	3—7	35

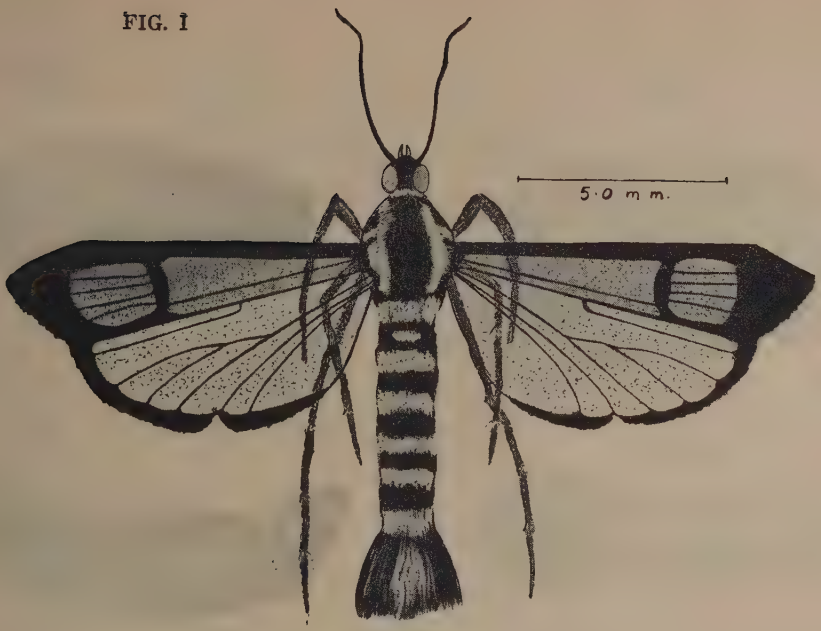
RESULTS: The oviposition started a few hours to one day after emergence.
It lasted for two to four days. Within that time a female can lay 255 to 300 eggs.
The adult life varies from three to seven days.
The females did not lay all the eggs found in her ovary.
After death these were dissected and they contained on an average from 35 to 67 eggs per female.

The Eggs:

The eggs (Fig. IIIa) are minute, inconspicuous and oval in outline with slightly flat top and bottom surfaces. On the top surface is a depression and the microphyle end is slightly indented. Freshly laid eggs are shining brownish yellow in colour measuring 1 mm long and 0.7 mm broad. One end of the egg is slightly narrower than the other end. After a day or two the colour gradually changes into shiny redish brown. The surface of the eggs are marked with minute and somewhat hexagonal reticulations. When about to hatch, the head of the larvae is seen as a very dark brown dot.

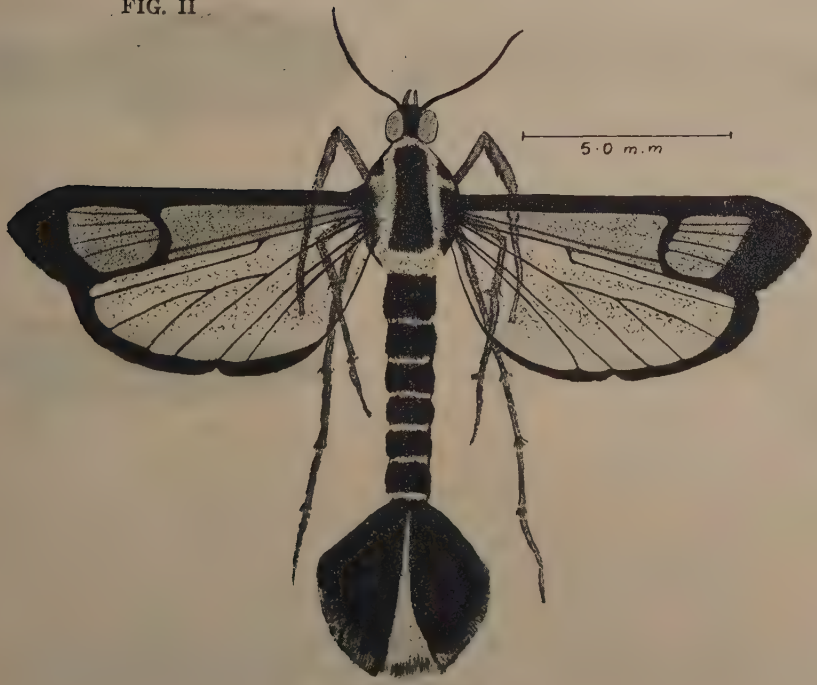
Many of the eggs collected from the field were parasitised by *Telenomus sp.* (*Scelionidae* : *Hymenoptera*) and the parasitism was found to be as high as 18 to 30 per cent (Table II). It was the first time that these parasites had been recorded on the eggs of *Conopia* in Malaya. The parasitised eggs were easily differentiated from healthy ones by their uniformly dull and dark colour.

FIG. I



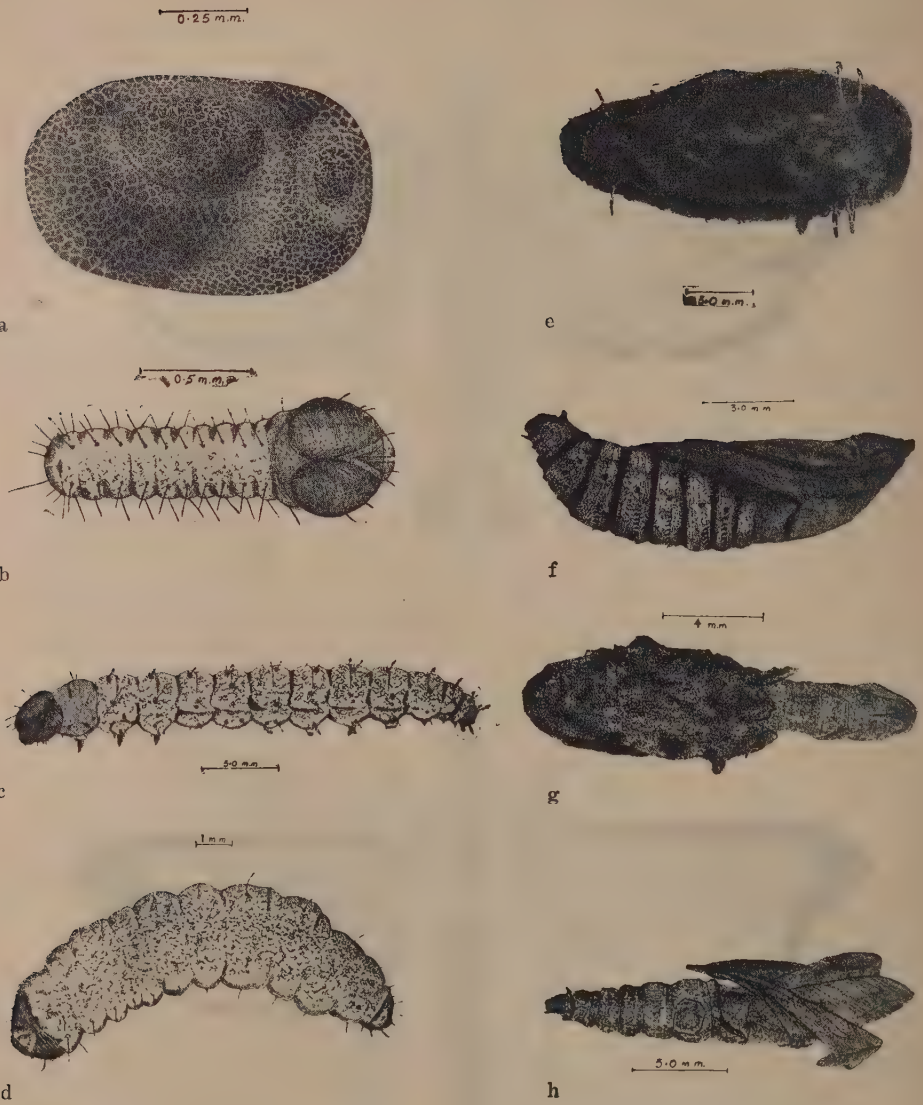
Adult—female

FIG. II



Adult—male

FIG. III



a—Egg
b—First instar larva
c—Full grown larva
d—Prepupa
e—Completed cocoon
f—Pupa
g—Pupal skin protruding from cocoon
h—Pupal skin taken out of the cocoon

Table II

Bimonthly Observation of Eggs collected from the Field for Viability and Parasitism for a Period of One Year from April 1958 to February 1959.

Months 1958—59	No. of eggs under observation	No. of eggs hatched	Percentage of viability	No. of parasites emerged	Percentage of parasitism	No. of eggs unhatched (if any)
April -	105	75	71.4	19	18.1	11
June -	89	60	67.4	27	30.3	2
August -	80	58	72.5	18	22.5	4
October -	125	90	72	25	20.0	5
December -	96	74	77.1	18	18.8	4
February -	150	107	71.3	37	24.6	6

RESULTS: (1) The viability of eggs is 68—72.5%. It was never found to be 100%.
(2) The parasitism of eggs was as high as 18—30%.

The eggs hatch within seven to nine days. (Table III). At first, the larva bites a small hole in the micropyle end and then enlarges it sufficiently to wriggle out by the peristaltic movements of its body. The whole process takes about 30 to 40 minutes.

Table III

The Incubation Period of Eggs under Laboratory Conditions.

Date of Oviposition	No of eggs under observation	No. of eggs hatched	Date of Hatching	Egg stage in days
5.5.58	39	12	12.5.58	7
		20	13.5.58	8
		5	14.5.58	9
7.6.58	52	14	14.6.58	7
		20	15.6.58	8
		15	16.6.58	9
10.7.58	68	17	17.7.58	7
		25	18.7.58	8
		19	19.7.58	9

RESULTS: The incubation period lasted 7—9 days.
Out of 159 eggs observed 147 eggs hatched.
No parasitism was observed on eggs laid in the laboratory.

The First Instar Larvae:

Newly hatched larvae (Fig. IIIb) were about 1.5 mm long, with a head much broader than the body, which is creamish white in colour.

The head is brown with a pair of strong and dark mandibles and a very prominent V-shaped marking, the apex of which extends to the posterior margin of the prothorax. The prothoracic shield is paler than the head. The ocelli, which are six in number, are shining pale white in colour. The posterior tip of the abdomen, which is narrower than the anterior region, is also of a pale brownish colour. The body surface is sparsely covered with comparatively long white hairs arising from isolated chitinous prominences (tubercles) on the body. There are nine pairs of rounded spiracles along the lateral sides of the body of which the first is the largest and situated on the prothorax. The remaining ones are placed one on each of the first eight abdominal segments. The last pair is larger than the other seven abdominal pairs and is placed more dorsaly at the posterior margin of the eighth segment. The larvae has 14 segments including the head capsule. The three pairs of thoracic legs and the five pairs of abdominal larval pods are prominent.

The newly hatched larvae are very active and when placed on the surface of a pod are found to crawl on it for about an hour or so before they find a suitable spot for tunneling their way inside for food and protection. The larvae take another hour or more for tunnelling before they are completely inside. As the larvae eat the soft tissues and boring progresses, minute brown pellets of excreta (mixed with dirt) are thrown out at the entrance of the tunnels. When the larvae grow, the size and amount of these pellets also increase and accumulate on the infested pods giving them a very characteristic appearance (Plates 1, 2).

The Full-Grown Larvae:

The mature larvae (Fig. IIIc) are creamish white in colour, except the head, the prothoracic shield, the thoracic legs, the margins of the spiracles and one or two markings on the last abdominal segment, which are brownish in colour and strongly chitinized. It has 14 segments, and measures about 16 to 19 mm. in length. In general appearance it resembles the larvae of peach tree borer *Conopia exitiosa* Say, a related species (Snapp) (4).

When disturbed, it ejects a large drop of reddish brown fluid from the posterior end of the body and wriggles away from the point of disturbance.

Due to the minute size during early stages and its boring habit it was not possible to find the number of moults and instars, but the duration of the entire larval life (till it completes the cocoon) was found in the field by liberating a number of newly hatched larvae on pods where there had been no previous attack of the insect and collecting the newly formed prepupae from the exit holes. The length of larval life was found to be between 30 to 37 days.

In the field, larvae were parasitized by *Elasmus nephantidis* ROHW (*Elasmidae* : *Hymenoptera*) which are fairly abundant throughout the year. Often one larva is parasitised by five or more parasites and as many as 38 adults were collected from a single host.

Table IV

Length of Larval Life in the Field.

No. of Larvae under observation	Date of Liberation of Larvae	No. of larvae made cocoons	Date of making cocoons	Time (in days) of larval life	Total number collected
38	21. 5.58	4	20.6.58	30	41
		8	21.6.58	31	
		10	22.6.58	32	
		16	24.6.58	34	
		3	25.6.58	35	
43	1. 7.58	3	1.8.58	31	39
		12	2.8.58	32	
		11	4.8.58	34	
		9	5.8.58	35	
		3	7.8.58	37	
59	10.10.58	2	10.10.58	31	50
		6	11.10.58	32	
		10	12.10.58	33	
		11	13.10.58	34	
		9	14.10.58	35	
		7	15.10.58	36	
		5	16.10.58	37	

RESULTS: In the field the larval life lasted from 30 to 37 days. The greatest number pupated between 32 to 34 days.

A day or so before pupating, the mature caterpillar makes an exit hole and then spins its cocoon. The inner layer consists mainly of spun fibres of a pale white colour which has a tough, parchment like consistancy. The cocoons are strengthened by incorporating large amounts of frass into the outside of these fibres and look like small lumps of frass, from which at first glance they are not easily distinguished. The cocoon is oval in outline with the anterior end broader than the posterior end (Fig. IIIe). It measures 13 mm long and .3 mm broad. The cocoon is attached to the tissues of the pod or stem by five or six strong, short, parchment like fibres which project from the surface of the cocoon.

The time taken to spin the cocoon is from 18 to 24 hours (Table V). After its completion the larva undergoes a certain degree of change into the prepupal stage.

Prepupae:

Prepupae (Fig. IIId) are much shorter than the fully grown larvae, the length being only 10 to 12 mm and 2.5 mm broad. The body is more opaque and whitish than that of the larva. At first, it moves by the wriggling movement of the body but later remains more or less motionless till it changesinto pupa. The segments of the body become more rounded and more distinct with deep inter-segmental grooves. The thoracic segments are large, the prothorax encircling the head, which at this stage is more or less tucked into the former. The first seven abdominal segments are distinct, the eighth and nineth being small and

tucked in. The last segment is brownish in colour and semi circular in outline with bluntly tapering tip. Duration of the prepupal life is one to two days (Table V). Prepupation takes place inside the cocoon made by the mature caterpillar.

Pupae:

The pupa (Fig. IIIf) is about 12 mm long and newly formed pupae are creamish white gradually turning into shining brown within 20 to 30 hours. In a day or two before the emergence of the adult, its body can be seen through the transparent pupal case and the colour of the pupa gradually deepens into bluish black as the time of emergence is neared.

The anterior end of the pupa is blunt, with a strong, short and blunt projecting spine which helps the pupa to break the cocoon before emergence. On its back, mostly on the abdomen, are one or two rows of stiff spines which also assist in helping the pupa out of the cocoon. After the adult emerges, the pupal skin protrudes about 2/3 of its length from the cocoon. (Fig. III g). The posterior end of the pupa is pointed and bears five or six strong, backward curved spines, which most probably hold the posterior end of the pupa in the cocoon. Under laboratory conditions the pupal stage lasts from 7 to 11 days.

Table V

Summary of Observations made on Mature Larvae for duration of Cocoon making and Prepupal and Pupal Stages.

No. of mature larvae under observation	Date of starting the cocoon	Date of completing the cocoon	Time (in hours) to make the coccon	No. of larvae prepupated	Date of prepupation	Date of pupation	Time (in days) of prepupal stage	No. pupated	Date of emergence of adults	Time (in days) of pupal stage	No. of adults emerged
10	5.2.58	6.2.58	22	10	6.2.58	8.2.58	2	10	16.2.58	8	9
16	10.2.58	11.2.58	24	16	11.2.58	12.2.58	1	16	19 20.2.58 21	7-9	16
7	20.2.58	21.2.58	18	7	21.2.58	23.2.58	2	6	4.2.58 5	9-10	6
12	3.3.58	4.3.58	18	12	4.3.58	6.3.58	2	11	14.3.58 15	8-9	10
8	17.3.58	18.3.58	24	8	19.3.58	20.3.58	1	8	28 30.3.58 31	8-11	8
10	25.3.58	26.3.58	22	9	26.3.58	27.3.58	1	9	4 5.4.58 7	8-11	9
12	2.4.58	3.4.58	20	12	3.4.58	5.4.58	2	12	12 13.4.58 14	7-9	11

Results: Time to make the cocoon varies from 18—24 hours.
Duration of prepupal life is 1—2 days.
Duration of pupal life is 7—11 days.

Emergence takes place by the pupal skin rupturing at the head and three thoracic segments along a T shaped suture (Figs III g, h) running along the anterior and lateral margins and the middorsal line. Through this the head region comes out first with the two front legs which permit it to have a hold on the substratum. It is then enabled to draw itself first upwards and then forwards gradually coming out of the cocoon completely. The adults usually emerge between 9 a.m. and 2.30 p.m.

When fully emerged, it rests for a while and the wings gradually expand on either side. To give them full expansion, the moth slowly raises them parallel to each other and when fully expanded raises both the pairs and holds them together vertically over the dorsal surface of its body and keeps them in this position for about five to seven minutes. When properly hardened they are returned to the normal position of rest along the sides of the body. The time taken for emerging is found to be between 20 to 30 minutes.

Many abnormal cases in which the wings failed to unfold properly after the emergence were found and in such cases the adults never mated nor lived the normal span of life. At the most they lived from a few hours to a day.

Sex Ratio:

Sexes are easily distinguished by their external features, already described. More females are always found than males. (Table VI).

Table VI

Sex Ratio: Bimonthly Observations of Adults for One Year.

Months—1958	Total number of adults emerged	No. of females emerged	Percentage of Females
February -	112	60	53.5
April -	180	94	52.2
June -	120	64	52.0
August -	82	42	51.2
October -	125	66	52.8
December -	159	85	53.4

RESULTS: Females are always in excess of males and the percentage of females was as high as 53.5 in February.

Significance of Life History:

In a tropical country like Malaya, where the temperature is more or less constant, with high and regular rainfall and without a distinct winter season, the insects feed and breed continuously throughout the year. From the knowledge gained so far, it can be safely stated that there are seven to eight or even more broods per year. The period between successive generations is short and favourable to their activity and so insects breed and multiply at all seasons, resulting in overlapping of generations. Individuals belonging to entirely different stages of development are found together on the same pods and stem in the field throughout the year.

The continuous feeding and breeding of *Conopia* throughout the year, their overlapping of broods, the short life-cycle, the tunnelling habits of all stages of larvae and the safe location of the pupae within the pods or stem, indicate that insecticidal application should be made at short and regular intervals.

It is also very clear, from this study, that the weak points in the course of development of this *Aegeriid* are when the eggs are on the surface of the pods or stem, or when the newly hatched larvae are on the surface of the pod or bark before finding a suitable spot for tunnelling. At these stages, however, their minute size renders them very inconspicuous and it is difficult to locate them on the pods or on the bark.

Type and Extent of Damage

The injury done by *Conopia* depends upon the boring habits of its larvae which tunnels into the stem and the pods for food. They attack trees of all ages. Damage caused is of a two-fold nature:

(1) They make extensive tunnelling, first in the shells of pods and, in extreme cases, proceed into the beans and make long galleries inside and between the seeds, filled with excreta and frass, lowering the quality of the seeds. They also attack stems.

(2) The pods and stems after infection become susceptible to secondary attack by insects like *Bradysia sp.* (*Sciaridae*: *Diptera*) and fungi to which the healthy trees are immune.

Conopia often infests pods which are first attacked by *Helopeltis* but at times attacks healthy pods.

On the pods, the damage is often superficial, affecting only the shell (Plates 1, 2 and 3) but in the case of extreme tunnelling the larvae attack beans and the pods decay or form a breeding place for secondary pests like *Bradysia sp.* Once the caterpillars reach the beans, which is not uncommon, the pods become useless. (Plate 5). If young pods 3 to 4 in. or less are attacked by six or more larvae, they often decay. Pods infested after they are half grown by the same number of larvae continue to grow, but if there are 12 or more of these in a single pod, the larvae first tunnel the shall (Plate 4) and then proceed to the beans, which are made unfit for fermentation due to extreme tunnelling. Fruits attacked nearer maturity are not much affected.

The caterpillars also attack the stems (Plate 7) and the injury caused when they are in abundance is serious. It attacks the stems and branches at different heights from a few inches to many feet above the ground level but seldom at or below the ground level, unlike *Conopia exitiosa* Say (Snapp) (4) or *Sanninoidea exitiosa* Say (Snapp, Thomson) (6). The infestation on stems is commonly superficial, affecting only the inner bark (Plates 6, 7) but at times the young branches are penetrated in an irregular manner to a depth of two to four cm. In such cases, the growth of the trees is affected and the trees thus

PLATE 1

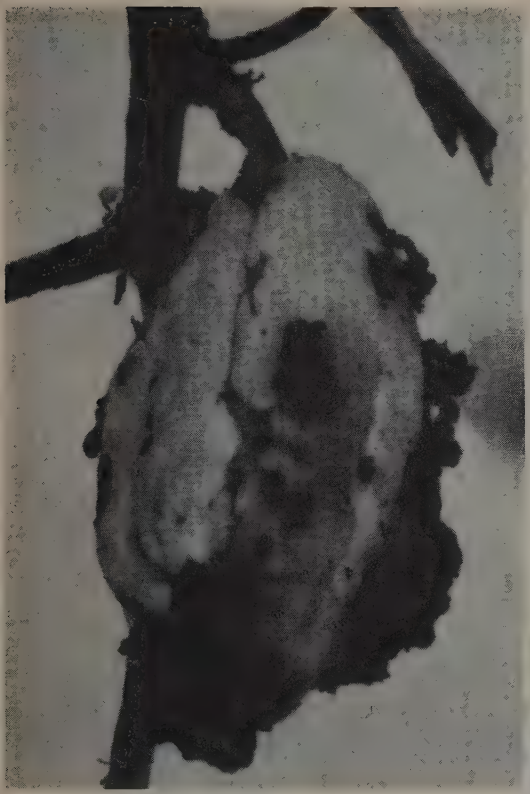


PLATE 2

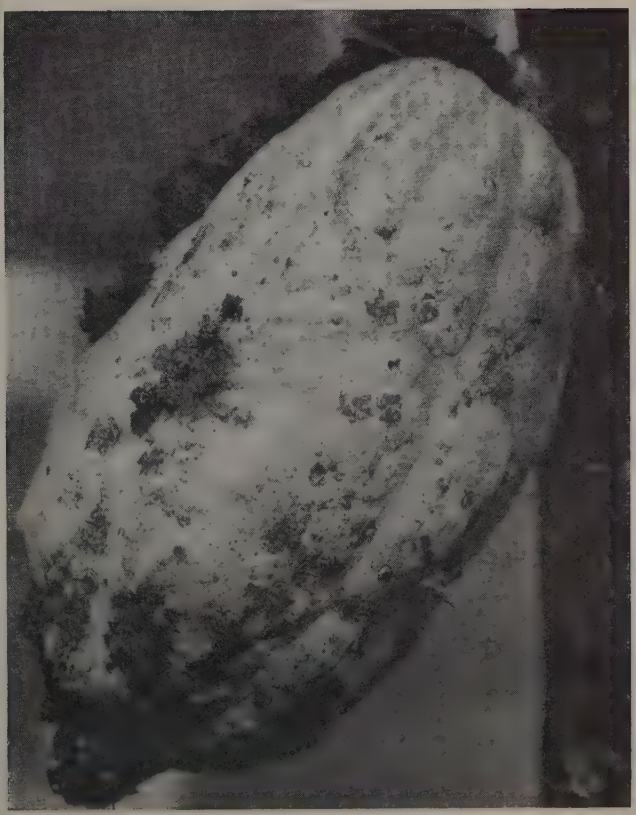


PLATE 1 and 2

Cacao Pods—Showing the frass exuding from attacked pods.

PLATE 7

An attacked stem of cacao.

PLATE 8

Attacked cacao stem showing frass and excrement mixed with dirt and gelatinous substance accumulating near affected parts.

weakened become more liable to infection and injury by other insects and fungi. In extreme cases, the branches wither away.

Symptoms of Attack:

Infested pods and branches can easily be recognised by the presence of large amounts of frass and excrement mixed with dirt, and a gelatinous substance exuded from the injured surface, accumulating on or near the affected spots (Plates 1, 8). The gelatinous exudation is more prominent in wet weather. Large amounts of these accumulates at the entrance to their holes probably protect the larvae and render them less susceptible to attack by predatory and parasitic insects. However, the presence of the first and second instar larvae are not easily detected in this way as the frass and excrement are expelled in extremely minute pellets.

Summary

The adults of *Conopia sp.* are small, clear wing moths about 1 to 1.2 cm. long and have a wing expansion of 1.8 to 2 cm. They are active day fliers which rest during night. On the wing these moths resemble wasps.

The females as well as males have both pairs of wings transparent, except the apex of the forewings. The females of this species differ from those of *Conopia exitiosa* and *Sanninoidea exitiosa*, both of which have anterior wings, opaque in the females.

The adult males and females are easily distinguished. The females have a broader abdomen with five or six very prominent yellowish bands. The males have a narrow, darker abdomen, with a longer tail fan. The males are stronger fliers.

The adults live from six to seven days. Oviposition starts from a few hours to a day after emergence and lasts two to four days. It occurs during daytime. A female may lay from 200 to 300 eggs. The ovaries of females examined after death contained 35 to 67 eggs, on average. The females always showed a preference when egg laying for pods and regions of stems already attacked by a previous generation of *Conopia* or by *Helopeltis*.

Eggs are small, oval in outline with bottom and top surface flat. When newly laid they are shiny yellowish in colour, gradually changing into shiny dark brown before hatching.

Eggs are parasitized by *Telenomus sp.* and this may be as high as 18 to 30 per cent in the field. Parasitized eggs are easily recognised by their dark and dull colour.

Incubation period is from seven to nine days. The process of hatching is described.

The first and fully grown larvae are described. The larval life lasts from 30 to 37 days. In the field larvae are parasitized by *Elasmus nephantidis*. When fully grown, larvae make cocoons within which they prepupate. The process of cocoon making takes about 18 to 24 hours. The prepupae is more opaque and shorter than the full grown larva and this stage lasts for one to two days.

Prepupa changes into pupa which lasts from seven to eleven days. While emerging, the pupal case projects about 2/3 from the cocoon. The process of emerging is described.

There are about four to five or more broods annually and there is a great deal of overlapping of generations in the field.

Due to their small size and tunnelling habits and overlapping of generations it is found to be extremely difficult to control them.

Females are almost always more numerous than the males and this preponderance may be as high as 53 per cent.

The damage is of a two-fold nature. They attack pods and inner bark of stems, lowering the quality of the pod or even making it worthless, and weakening the stem. The feeding tunnels attract and breed secondary pests like *Bradysia sp.*

Acknowledgments

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COMPLEMENTARY ISOLATES OF *PHYTOPHTHORA PALMIVORA* FROM MALAYA

BY

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During a recent survey at the West African Cocoa Research Institute, Ghana, on the distribution of strains of *Phytophthora palmivora* (Butl.) Butl., the causal fungus of black pod disease and other infections of cocoa, comparisons were made between cocoa isolates from West Africa and isolates from cocoa, durian, orchid and rubber received from Malaya. Until quite recently, the pathogen had not been recorded from cocoa in Malaya, and the isolate used in the comparative tests had been made from a diseased pod found at the Federal Experimental Station, Serdang. West African cocoa isolates of the 'cacao' and 'rubber' groups of the species were obtained from Ghana and Nigeria respectively (Turner, 1960). The relationships of the isolates were examined by intercrossing them and recording the production of oospores. All isolates grew well on 4 per cent oatmeal agar, and oospore production by complementary isolates was induced by growing the isolates in paired cultures. The cultures were examined after three weeks for the presence of oospores. Oospore formation was rare at normal laboratory temperatures (approx. 85°F) but was plentiful in the appropriate paired cultures when they were incubated at 60°F. Throughout the tests strict phytosanitary precautions were maintained; all experiments were under controlled conditions in the laboratory and discarded material was sterilised by autoclaving before disposal.

No oospores were found in single cultures from any host at the end of the test period. Paired cultures of the cocoa isolate from Ghana, belonging to the 'cacao' group of the species, and isolates from durian, orchid and one isolate from rubber produced abundant oospores with amphigynous antheridia. Dimensions of the oospores were similar to those recorded by earlier workers (e.g. Ashby, 1929) in paired cultures of 'cacao' and 'rubber' group isolates. No oospores were found in the same series when the Ghanaian cocoa isolate was replaced by either the 'rubber' group cocoa pathogen, which is dominant in Nigeria, or an isolate from rubber obtained from Ceylon. Oospore production was also absent in intercrosses between the durian, orchid and rubber isolates. The Malayan cocoa isolate, however, was found to be similar to the Ghanaian isolate, forming oospores in paired cultures with the durian, orchid and the rubber isolate. Another rubber isolate failed to produce oospores in paired culture with any isolate of *P. palmivora* from both 'cacao' and 'rubber' groups from widely-spaced countries, and was similar in this respect to occasional isolates from cocoa from Sierra Leone and Angola; it is possible that this isolate was distinct from *P. palmivora*.

In a recent paper, Thompson (1959) described investigations into a blight of orchids in Singapore caused by *P. palmivora*, and also compared the pathogen with isolates of the same species from rubber. As a result of his observations he suggested that the isolates from the two hosts were very similar and provisionally identified the orchid pathogen as belonging to the 'rubber' group. Crossing tests with a known isolate of the 'cacao' group have confirmed this identification, and have shown the isolate from durian also to be of the 'rubber' group.

The Malayan cocoa isolate belonged to the 'cacao' group and was sexually complementary to the pathogen occuring on other hosts. With the extension of cocoa growing in Malaya it might be anticipated that the incidence of black-pod disease will reach higher levels, and that the dominant strain of the fungus occuring on cocoa will belong to the 'cacao' group of the pathogen. It is not known whether crossing of complementary strains occurs under natural conditions, but should this occur the increasing level of the 'cacao' strain in a country where the 'rubber' strain is already widely distributed could result in a range of genetic variation, possibly influencing the pathogenicity of the strains.

I am greatly indebted to the following persons for their assistance in sending isolates used in the comparative tests: Mr. G. S. Keeping, Department of Agriculture, Kuala Lumpur; Mr. A. Newsam, Rubber Research Institute of Malaya, Kuala Lumpur; and Dr. Molly Smith, Department of Botany, University of Malaya, Singapore.

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QUALITY TESTING OF RICE IN MALAYA WITH PARTICULAR REFERENCE TO MILLING AND COOKING

BY

T. K. VAN (*Botanist*)

Introduction

Although yield, disease resistance and other field characteristics are the main considerations in breeding new padi varieties, the importance of grain quality cannot be disregarded.

The consumer's preference is influenced by his eating habits and methods of cooking and it is, therefore, difficult to define quality. For example, the type of cooked rice considered by the Japanese to be of good quality is soft and sticky, on the other hand people who eat curries like their rice to be dry and flaky.

In order that a new variety may be considered suitable for planting in Malaya it should have the following characteristics:—

Consumer	*Miller*	*Farmer*
Long uniform grains.	High ratio of rice to grain.	High yield.
Absence of red grains.	Grain uniformity.	Disease and pest resistance.
Few broken grains.	Good, clean appearance.	Lodging resistance.
Flakiness when cooked.	No awns.	Drought/flood resistance.
High volume expansion when cooked.		Suitable maturation period.
		Ease in threshing
		High grain weight per unit volume, etc.

Various methods have been developed to determine rice quality in the laboratory and this paper presents an account of those used by the Department of Agriculture in Malaya.

Materials and Methods

MILLING

For small sample testing (i.e. samples of less than one kilogram of unhulled rice), the padi is sun dried for two hours, and then stored over sodium chloride (1) in an air tight box for 24 hours so that all samples will attain their moisture content equalibrium under standard conditions. The moisture content of each sample is then determined by means of a Marconi moisture meter.

A 150 gm. sample of padi is put through a McGill sheller * three times so that almost all the husk is removed. The quantities of hulled

* McGill sheller, single phase, 60 cycles, ¼ h.p.

rice and husk are then determined by actual weighing. A ¼ h.p. McGill miller is then used to polish the hulled rice for 60 seconds with a 5 kilo weight on top of the cover. The difference in weight between the hulled and polished rice represents the amount of bran in the sample.

The polished rice is passed through a Cole's sample separator to separate the whole grains from the broken grains. The weight of each fraction is determined by direct weighing.

For samples of more than one kilogram unhulled rice, the large McGill miller † is used instead of the small ¼ h.p. mill, and with this machine the quantity of bran can be determined by direct weighing.

Cooking

The volume of a 10 gm. sample of whole polished rice is determined by water displacement.

The rice is then poured into a perforated container and placed in a 250 c.c. beaker containing about one inch of boiling water. This is allowed to boil for eight minutes, after which time the sample is hooked up above the water and steamed for a further ten minutes. The beaker is then removed from the heat for a full minute to allow the steam and water to settle down. A few grains are cut across with a sharp knife or razor blade to determine whether the rice is cooked or not. Cooked rice will be firm and opaque; uncooked rice has a hard, gritty centre. Overcooked rice has fissures radiating from the centre and disintegrates easily.

Stickiness is indicated by the formation of a ball, when a teaspoonful of rice is rolled between the fingers. Rice which does not form a ball is regarded as flaky.

Finally the rice is transferred to a measuring cylinder and the volume of the cooked rice determined by water displacement. The amount of expansion of the sample on cooking is known as the "Imbibition Ratio" or "Swelling Number." Imbibition Ratio $= \frac{\text{Volume of cooked rice.}}{\text{Volume of uncooked rice.}}$

A detailed procedure for the quality testing of rice in Malaya is given in Appendix A.

Results

Using the techniques described, consistent figures have been obtained for the different components of any one variety. For example, a series of millings, done for the variety *Bangkok*, showed very little variation (Table I).

On the basis of these results it can be assumed that any big differences between varieties are due to the samples themselves and not due to the milling techniques or experimental error. Tables II and III show that differences are less between strains of the same variety than between different varieties.

† McGill miller No. 3, 3 h.p.

Table I

Test Milling of the Padi Variety Bangkok
(weight in gm.)

No.	Padi	Husk	Bran	Broken rice	Whole rice	I.R.
1.	150	35.1	10.5	4.01	100.39	3.09
2.	150	35.1	9.9	3.77	101.23	3.26
3.	150	35.8	9.2	3.95	101.05	3.07
4.	150	35.2	9.5	3.87	101.43	3.12
5.	150	35.1	9.8	3.85	101.43	3.10
6.	150	35.3	9.6	3.85	101.25	3.08
7.	150	35.3	9.6	3.85	101.25	3.12
8.	150	35.2	9.9	3.90	101.25	3.17
9.	150	35.1	10.0	3.87	101.03	3.11
10.	150	35.1	9.6	3.86	101.44	3.12
Mean	—	35.23	9.76	3.88	101.17	3.12
S.E.	—	± 0.07	± 0.11	± 0.02	± 0.10	± 0.02

Table II

Results of Milling Tests on Siam Strains (Between Strains)
(Weight in gm.)

No.	Strain No.	Padi	Husk	Bran	Broken rice	Whole rice	I.R.
1.	13	150	30.0	10.20	4.85	104.95	2.75
2.	11	150	31.3	10.70	20.83	87.17	2.96
3.	59	150	31.3	10.04	26.96	81.70	3.02
4.	56	150	31.4	6.10	8.25	104.25	2.75
5.	38	150	31.5	11.20	2.85	104.45	3.13
6.	73	150	31.5	10.20	34.45	73.85	3.08
7.	54	150	31.5	11.20	4.58	102.72	2.89
8.	69	150	31.5	9.48	6.75	102.27	2.96
9.	25	150	31.8	8.10	5.45	104.65	2.61
10.	Sm. 29	150	31.9	12.40	7.50	98.20	2.92
11.	18	150	32.2	10.10	17.75	89.95	2.87
12.	6	150	32.2	8.70	7.15	101.95	2.82
13.	72	150	32.2	10.15	10.25	97.40	2.89
14.	70	150	32.3	12.50	32.50	72.70	3.01
15.	48	150	32.5	9.50	8.50	99.50	3.17
16.	32	150	32.5	8.60	8.15	100.75	2.87
17.	16	150	32.8	9.60	7.20	100.40	3.24
18.	24	150	33.0	9.80	6.70	100.50	3.07
19.	20	150	33.2	10.40	7.75	98.65	2.50
20.	42	150	33.2	7.50	32.40	76.90	2.96
21.	46	150	33.2	9.80	25.25	81.75	3.50
22.	26	150	33.2	10.90	8.44	97.46	3.15
23.	10	150	33.4	10.40	21.37	84.83	2.68
24.	71	150	33.4	10.00	6.07	99.93	3.06
25.	29	150	34.0	9.06	21.60	85.14	3.10
Mean	—	150	32.28	9.87	13.74	94.08	2.96
S.E.			± 0.18	± 0.28	± 2.01	± 2.07	± 0.04

(NOTE: Each figure in the Table is the mean of three tests which were consistent.)

Table III

Results of Milling Tests on Different Varieties Chosen at Random (Between Varieties)
(Weight in gm.)

No.	Strain No.	Padi	Husk	Bran	Broken rice	White rice	I.R.
1.	Siam	1000	215.5	65.7	87.7	631.1	3.00
2.	Nachin	1000	200.4	54.5	59.9	685.2	3.81
3.	Bangkok	1000	234.8	65.1	25.9	674.2	3.12
4.	R. Ebos	1000	200.0	100.0	99.0	601.0	*
5.	LH 51085	1000	205.0	130.0	60.0	605.0	*
6.	LH 51034	1000	200.0	125.0	261.0	414.0	*
7.	LH 51026	1000	210.0	85.0	241.0	464.0	*
8.	HC 3	1000	210.0	115.0	232.0	443.0	*
9.	HC 33	1000	215.0	105.0	430.0	250.0	*
10.	HC 20	1000	210.0	115.0	124.0	551.0	*

(* Not tested.)

Commercial Rice

Commercial rice is graded into different classes without regard to cooking quality. The grading depends upon the grain types and quantity of broken grains (Appendix B). Long grains are given better grading than short grains and the same variety, subjected to differences in milling, is graded differently, according to the percentage of broken grains present. It is obvious, therefore, that rice classified as low grade, due to a large percentage of broken grains, could be improved by sieving.

The commercial grading of rice depends largely on its condition after milling, and the plant breeder can only try to ensure that the miller is provided with potentially good grain.

Discussion

In assessing the quality of rice in Malaya, especially in regard to milling quality, one has to bear in mind the important fact that rice mills in this country are not standardised. They range from small private mills to large commercial and Government mills. Because of this wide variation, it is difficult to test the quality of rice in the laboratory under conditions which are "typical" of an average mill. Laboratory assessments of quality, under the best conditions that can be obtained, therefore give the "potential" milling quality and results from commercial mills are invariably lower. Further investigations are needed to establish the relationship between potential milling quality and commercial milling.

Discrepancies between laboratory assessment and commercial milling are due to factors, such as: the degree of milling and polishing for which the mills are set; the degree of ripeness of the grain; pest and fungus infestation and moisture content of the grains at milling.

Infestation by pests and diseases, unripe grains, hard milling and high moisture content, all result in more broken grains. Of these factors, moisture content probably has the greatest influence on milling quality

and yet this is a factor which the commercial miller finds difficult to control. For laboratory assessment, it has been shown that padi stored at 14 per cent moisture content and milled at 10 to 11 per cent moisture content gave the minimum breakage (2). This moisture level is approached under laboratory conditions in Malaya by sun drying and then storage over sodium chloride. The value obtained by this method is 11.2 per cent (± 0.8).

In contrast to milling tests the performance of rice samples under cooking tests is decided more by their inherent genetical make-up than by subsidiary environmental effects. It remains to be seen, however, if the new hybrid selections (between indica and japonica varieties) will be acceptable to the consumer when they reach him on a plate.

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Appendix A

Procedure in Quality Testing of Rice

1. Sun dry padi for two hours.
2. Place samples over NaCl in airtight box for 24 hours.
3. Take out very small sample from each sample for moisture determination.
4. Weigh out 150 gm. (if sample small) or 1,000 gm. (if sample big).
5. Pass through McGill sheller three times.
6. Weigh husk and hulled rice.
7. Polish for one minute in ¼ h.p. McGill mill (small sample) or 40 seconds in McGill miller No. 3 (big sample).
8. Weigh polished rice.
9. Determine weight of bran.
10. Separate broken and whole rice in Cole's separator.
11. Weigh each portion.
12. Weigh out 10 gm. whole rice.
13. Determine volume in 25 ml. measuring cylinder by water displacement.
14. Pour into wire basket. Put basket into covered beaker with enough boiling water to cover the rice.
15. Boil for eight minutes on medium switch.
16. Hook up above water and allow to steam for ten minutes.
17. Remove heat for one minute to allow for settling.
18. Observe texture by cutting with sharp knife or razor.
19. Knead a few grains between fingers to find out whether sticky or flaky. Observe appearance and other qualities.
20. Place cooked rice into 100 ml. measuring cylinder with 50 ml. water. Observe volume of cooked rice.

21. Obtain Imbibition Ratio with the following formula:

$$\frac{\text{Volume of cooked rice}}{\text{Volume of uncooked rice}} = \text{I.R.}$$

APPENDIX B

FACTORS INFLUENCING THE GRADING OF COMMERCIAL RICE

In addition to degree of milling the following factors influence the grading of commercial rice:—

1. **Classes of Milled Rice**

(a) Long Grain Class 1:—
80 per cent or more of kernels of minimum length of 7.0 m.m. and not more than 20 per cent to be equal or better than "Long Grain Class 2".

(b) Long Grain Class 2:—
80 per cent or more of kernels of minimum length of 6.5 m.m. and a maximum length of 7.0 m.m. the balance of 20 per cent to be equal or better than "Long Grain Class 3".

(c) Long Grain Class 3:—
80 per cent or more of kernels of minimum length of 6.0 m.m. and a maximum length of 6.5 m.m. the balance of 20 per cent to be equal or better than "Short Grain Class 1".

(d) Short Grain Class 1:—
80 per cent or more of kernels of minimum length of 5.0 m.m. and a maximum length of 6.0 m.m. the balance 20 per cent to be equal or better than "Short Grain Class 2".

(e) Short Grain Class 2:—
Rice of which kernels have a minimum length of 5.0 m.m. and a maximum length of 5.5 m.m.

(f) Large Broken: Three quarters or more of whole grain.
Broken: less than three quarters of whole grain.

2. **Grades of Rice**

GRADE 1 A:

Grain Classification:

	%	
Long Grain Class 1	70	
" " " 2	25	(max.)
" " " 3	5	(max.)

Composition :

Whole rice	85	(min.)
Large Broken	13	(max.)
Broken	2	(max.)

GRADE 1 B:

Grain Classification:

Long Grain Class 1	50	
" " " 2	40	(max.)
" " " 3	10	(max.)

Composition :

			%
Whole rice	....	....	85 (min.)
Large Broken	....	....	12 (max.)
Broken	....	....	3 (max.)

GRADE 1 C:

Grain Classification:

Long Grain Class 1	....	35
„ „ „ 2	....	50 (max.)
„ „ „ 3	....	15 (max.)

Composition :

Whole rice	....	....	85 (min.)
Large Broken	....	....	11 (max.)
Broken	....	....	4 (max.)

GRADE 2:

Grain Classification:

Long Grain Class 1	....	15
„ „ „ 2	....	40
„ „ „ 3	....	45
Variation ±	....	2

Composition :

Whole rice	....	....	78
Large Broken	....	....	15-17
Broken	....	....	5-7
Chalky grains	....	....	< 1
Red grains	....	....	< 2
Damaged grains	....	....	< 0.25

GRADE 3:

Grain Classification:

Long Grain Class 2	....	25
„ „ „ 3	....	60
„ „ „ 1	....	15
Variation ±	....	2

Composition :

Whole grain	....	....	76
Large Broken	....	....	12-14
Broken	....	....	10-12
Chalky grains	....	....	< 2
Red grains	....	....	< 3
Yellow grains	....	....	< 1

GRADE 4:

Grain Classification:

Long Grain Class 3	....	50
Short Grain Class 1	....	50
Variation ±	....	2

Composition :

Whole grains	....	....	65

		%
Large broken	....	18-20
Broken	....	15-17
Chalky grains	....	< 3
Damaged and Yellow grains		< 2
Red Grains	....	< 5
Soreign matter	....	< 0.25

GRADE 5:

Grain Classification:

Long Grain Class 3	....	25
Short Grain Class 1	....	50
„ „ „ 2	....	25
Variation ±	....	2

Composition :

Whole grain	....	55
Large broken	....	20-25
Broken	....	20-24
Chalky grains	....	< 5
Red grains	....	< 7
Damaged and Yellow grains		< 3
Foreign matter	....	< 0.25

GRADE 6: ....

Grain Classification:

Short Grain Class 1	....	60
„ „ „ 2	....	40
Variation ±	....	3

Composition :

Whole grains	....	45
Large broken	....	27-30
Broken	....	25-30
Chalky grains	....	< 10
Damaged and Yellow Grains		< 4
Red Grains	....	< 10
Foreign matter	....	< 0.50

GRADE 7:

Grain Classification:

Short Grains Class 1	....	50
„ „ „ 2	....	50
Variation ±	....	5

Composition :

Whole grains	....	35
Large broken	....	25-30
Brokens	....	35-43
Chalky grains	....	< 15
Damaged and Yellow grains		< 5

		%
Red grains	....	< 12
Foreign matter	....	< 0.5

GRADE 8:

Grain Classification:

Short Grain Class 1	....	40
„ „ „ 2	....	60
Variation ±	....	5

Composition :

Whole grain	....	25
Large broken	....	25-30
Broken	....	45-53
Chalky grains	....	< 15
Damaged and Yellow grains		< 6
Red grains	....	< 14
Foreign matter	....	< 0.5

THE RELATION OF FLOWERING AND MATURATION PERIOD IN SOME MALAYAN RICES TO SOWING DATE AND LATITUDE

BY

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Introduction

During the past few years tests have been made with a number of Malayan rice varieties throughout the country with the aim of determining the relation of sowing date and latitude to time of harvest in various regions. This paper presents in summarised form the results of the majority of these field experiments in the hope that field officers may take them into consideration when determining the most suitable sowing dates of some of the commonest varieties. The data has been taken from the files in the Botany Division of the Department of Agriculture and from experiments carried out under the writer's supervision. It does not claim to be exhaustive or comprehensive in scope, for many widely used varieties are missing from the lists or have not been tested in all areas of the country, or at all times of the year. It is hoped that other workers will fill in the gaps in the data. A report by Jagoe (4) has already shown that considerable variation in maturation periods of some common varieties is found between the north and south of the Federation in a variety sown on the same date in different latitudes. The periodical reports on the Departmental Rice Variety Trials (Larter, 5, 6.) briefly draw attention to the effect of both sowing date and latitude on maturation and flowering (ear emergence).

METHOD OF PRESENTATION OF THE DATA

The main factor to be considered in presenting these results is that of latitude, and secondly the time during which seedlings remain in the nurseries. Most of the data recorded here is for a nursery of about 40 days. Attention is drawn in the record below to any exceptions. No consideration has been given to relating the results to any particular ecological area or soil type within a given latitude, as the experiments have not been distributed over a sufficiently wide area.

For the purposes of presentation of these results the Federation has been divided into latitude groups as follows:—

South	....	less than			2°	30′N
South Central	....	2°	31′	to	3°	30′N
Central	....	3°	31′	to	4°	30′N
North Central	....	4°	31′	to	5°	30′N
North	....	more than			5°	31′N

For some records it has been necessary to present data covering only

two of these groups. Data for the Central and North Central region is scarce and these two regions have been omitted completely in many cases. The natural length of day variation at a number of latitudes is shown in Fig. 1. In Singapore (Lat. 1° 18'N) the difference between the longest and shortest day is 8 mins, in Malacca (Lat. 2° 12') it is 14 mins, in Kuala Lumpur (Lat. 3° 08'N) it is 20 mins and in Alor Star and Kota Bahru (Lat. 6° 09'N) it is 40 mins. The shortest days occur throughout the country between about the 15th September to the 15th January, and it is during this period that the main rice growing season falls. If the data given below and the curves given for Siam 29 in Figure 2 are compared with these day length curves, it will be seen that the time to flowering is at a minimum for those sowings made in late July/August and the beginning of September. The shortest short-days, and the maximum number of short-days will therefore be available to plants sown during these dates. In the experiments reported here sowing dates have not always been made at the beginning of the month. It is not sufficient, however, to record merely the month of sowing, for other experiments have shown (Dore , 2) that very small differences in day length can induce large differences in time to flowering and to maturation. Therefore, where the data has made this necessary the year has been divided into approximately 10 day intervals, the beginning (1st to 10th), middle (11th to 20th) and the end (21st to 31st) of the month being used to designate these intervals.

Yield data has also been included where reliable records are available.

The Data

Varieties tested in both the North and South of the Federation

The detailed results for each variety tested in both the north and south of the Federation are presented separately. General comments on the results are however given at the end of this section.

Acheh Puteh. (Table I)

This variety has been grown and tested for photosensitivity only in the North, South Central and South latitude regions. Sowings covering the whole year are available only in the North and South regions. The seedlings used for this variety varied in age between 39 to 44 days. It is therefore unlikely that any differences in the number of days to flowering have been caused by nursery treatment. The results have therefore been presented as if all plants were transplanted 40 days after sowing. All sowings were made at the beginning of the month. There are no yield figures available from sowing date experiments.

Anak Naga. (Table II)

This variety has only been tested for photosensitivity in the North and South latitude regions. The seedlings used were in all cases

40 days old at transplanting, and all but one sowing was made at the beginning of the month. No record of the period from sowing to harvest is available for the South region. No yield data is available from the experiments summarised. One sowing in the South was made at the end of May but as this was so close to the June sowing the two results have been averaged and included in June and the May sowing has been omitted. This does not appear to have altered the trend of the results.

Table I

Relation of Sowing Date and Latitude to Time to Flowering and Harvest (in days) for the variety Acheh Puteh

Latitude Group	Time to	Month of sowing. All sowings in the 1st part of the month											
		Jan.	Feb.	Mar.	Apr,	May	June	July	Aug.	Sep.	Oct,	Nov.	Dec.
South	Flowering	329	303	236	—	172	159	154	145	145	166	195	373
	Harvest	—	—	—	—	188	178	180	168	163	—	—	—
South Central	Flowering	—	—	—	140	147	148	150	156	149	—	—	—
	Harvest	—	—	—	203	184	188	180	183	—	—	—	—
North	Flowering	145	154	156	149	142	136	133	126	127	128	130	127
	Harvest	178	204	191	189	179	178	165	156	165	160	167	173

Table II

Relation of Sowing Date and Latitude to Time to Flowering and Harvest (in days) for Anak Naga

Latitude Group	Time to	Month of Sowing											
		Jan.	Feb.	Mar.	Apr,	May	June	July	Aug.	Sep.	Oct,	Nov.	Dec.
South	Flowering	—	180	186	186	—	198	196	181	172	159	162	—
North	Flowering	320	300	275	240	216	188	168	150	140	136	148	139
	Harvest	347	332	308	265	242	217	202	185	176	170	179	175

Mayang Sa Gumpal. (Table III)

In the South and South Central regions this variety has been tested during the months of April, May, June and July. This is perhaps unfortunate, for it is unlikely that the minimum time to flowering and

sowing in these regions has been recorded in the tests summarised. The duration of the nursery has been from 40 to 45 days in all cases, and in the South Central region some yield data has been obtained (Table IV). The yield figures are the mean of two observations. All sowings noted have been made at the beginning of the month.

Table III

Relation of Sowing Date and Latitude to Time to Flowering and Harvest (in days) for Mayang Sa Gumpal

Latitude Group	Time to	Month of Sowing											
		Jan.	Feb.	Mar.	Apr,	May	June	July	Aug.	Sep.	Oct,	Nov.	Dec.
South	Flowering	—	—	—	224	211	202	192	—	—	—	—	—
	Harvest	—	—	—	267	257	248	233	—	—	—	—	—
South Central	Flowering	—	—	—	208	193	175	166	—	—	—	—	—
	Harvest	—	—	—	286	271	243	232	—	—	—	—	—
North	Flowering	176	218	282	243	216	192	178	154	146	153	160	173
	Harvest	209	241	310	267	237	221	208	192	180	182	186	184

Table IV

Relation of Yield of Grain in lb/acre to Sowing Date for Mayang Sa Gumpal

Latitude Group	Month of Sowing			
	April	May	June	July
South	1298	1399	1500	1360

Pahit. (Table V)

This variety has only been tested for all sowing dates in the North region. In the South Central region, the only other area where it has been tested, data is available only for the months of April to September. The incomplete data from the South Central region is unfortunate, as it is possible that the minimum flowering period has not been recorded. The nursery has in all cases been 39 or 40 days. The data for time from sowing to harvest obtained from the South Central region may not be reliable. This also applies to other such data from this region, and the reasons for viewing it with caution are given in Section D below.

Table V

Relation of Sowing Date and Latitude to Time to Flowering and Harvest (in days) for the variety Pahit

Latitude Group	Time to	Month of Sowing (beginning of the month)											
		Jan.	Feb.	Mar.	Apr,	May	June	July	Aug.	Sep.	Oct,	Nov.	Dec.
North	Flowering	324	290	264	232	201	174	157	143	130	126	137	140
	Harvest	351	321	311	251	229	199	200	175	163	164	172	175
South Central	Flowering	—	—	—	222	203	190	188	181	154	—	—	—
	Harvest	—	—	—	262	234	228	232	—	—	—	—	—

Radin Siak 34. (Tables VI, VII, VIII, IX)

The results available for this variety are considerably more extensive than those available for other varieties. The majority of results (Table VI) are from tests carried out with seedlings aged between 35 to 45 days. Only in the South and North latitude group, however, have sowings been made in all months of the year. In the South Central and Central latitude groups sowings have only been made in a few months in the middle of the year. The sowings covering this series have all been made at the beginning of the month.

Table VI

Relation of Sowing Date and Latitude to Time to Flowering and Harvest (in days) for Radin Siak 34

Latitude Group	Time to	Month of Sowing											
		Jan.	Feb.	Mar.	Apr,	May	June	July	Aug.	Sep.	Oct,	Nov.	Dec.
South	Flowering	239	226	191	160	151	148	145	140	140	149	147	145
	Harvest	—	—	—	236	203	183	172	166	160	164	168	—
South Central	Flowering	—	—	—	161	154	160	155	156	149	152	—	—
	Harvest	—	—	—	204	—	193	196	196	182	194	—	—
Central	Harvest	—	—	—	202	190	189	189	—	—	—	—	—
North	Flowering	142	179	181	154	146	142	139	130	129	126	128	128
	Harvest	184	224	223	188	186	184	170	162	166	162	167	180

One record is available from the South Central latitude group (Table VII) where a short nursery period has been used. Seeds in this test were initially grown for from 5 to 10 days in petri dishes and then transplanted directly into pots. The initial sowings were made both at the beginning and middle of the month. The differences between successive sowings do not, however, appear large enough to warrant separate recording and they are thus presented as though all sowings were made in the middle of the month. Records are also available (Table VIII) from sites close to latitude 3° 30'N, for seedlings grown in the nursery for more than 45 days. They are only available for sowing dates from the beginning of March to the beginning of July. Yield data is also available from these tests (Table IX).

Table VII

Relation of Sowing Date to Time to Flowering and Harvest in the South Central latitude group (in days) for Radin Siak 34, transplanted after a Nursery Period of 5 to 10 days

Time to	Date of Sowing (middle of month)											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec,
Flowering	117	123	130	124	127	124	122	118	119	119	123	119
Harvest	154	180	171	164	166	160	155	154	150	153	153	152

Table VIII

Relation of Sowing Date to Time to Flowering and Harvest At Latitude 3° 30'N (in days) for Radin Siak 34, transplanted after a Nursery Period of more than 45 days

Time to	Month of Sowing				
	March	April	May	June	July
Flowering	168	157	152	145	137
Harvest	—	202	202	194	187

Table IX

Relation of Yield to Sowing Date for Radin Siak 34 grown at Latitude 3° 30'N

Mean Yield lb/acre	April	May	June	July
	709	1180	979	1386
	(5) *	(5)	(4)	(4)

( ) * number of observations averaged.

Rambutan (Table X)

This variety has been tested in sowing date experiments only in the North and South latitude regions of the peninsula. Seedlings were all 40 days old at transplanting. No harvest data is available from the South latitude group. All sowings have been made at the beginning of the month.

Table X

Relation of Sowing Date and Latitude to Time to Flowering And Harvest (in days) for Rambutan

Latitude Group	Time to	Month of Sowing											
		Jan.	Feb.	Mar.	Apr,	May	June	July	Aug.	Sep.	Oct,	Nov.	Dec.
South	Flowering	—	—	274	250	—	250	229	213	204	164	—	—
North	Flowering	229	286	274	236	208	184	166	144	138	138	153	149
	Harvest	265	330	310	263	241	216	200	180	177	178	189	180

Table XI

Relation of Latitude and Sowing date to Time to Harvest (in days) for Siam 29

Latitude Group	Month of Sowing											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
South	—	—	—	248	218	213	196	180	193	184	—	—
South Central	—	—	—	245	214	210	203	—	—	—	—	—
North	327	314	310	250	224	204	189	176	164	162	168	171

Table XII

Relation of Sowing Date to Time to Flowering and Harvest (in days) in the South Central Latitude Region for Siam 29, transplanted when 5 to 10 days old

Time to	Month of Sowing (Middle of the month)											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Flowering	160	165	180	178	170	151	140	130	129	134	132	132
Harvest	199	228	219	214	—	189	178	167	163	166	166	166

Siam 29 (Tables XI, XII, XIII and Figure II)

Data for time to flowering and harvest is available from the North, South Central and South latitude regions (Table X, Figure II) and some yield date (Table XII) is available from the North latitude region. All transplanted seedlings have been between 39 and 41 days old, except for one series of observations (Table XI) made in the South Central region where seedlings have been transplanted when between 5 to 10 days old. Sowings were made at the beginning of the month for seedlings transplanted when 40 days old, and in the beginning and middle of the month when 5 to 10 days old. The difference between successive sowings of the 5 to 10 day old seedlings do not appear large enough to warrant separate recording and the data is therefore presented as if all sowings were made in the middle of the month. The data for time to flowering in the North, South Central and South latitude regions for the 40 day old seedlings has been separately presented in histogram form (Figure II). This diagram should be compared with the natural daylengths shown in Figure I.

Table XIII

Relation of Grain Yield to Sowing Date in Siam 29 in the North

	Month of Sowing						
	Jan.	April	May	June	July	August	Sept.
Yield lb./acre	1331	5184	4445	2913	3586	2192	2394
No. of observations	2	2	3	2	3	2	2

Taichu 65 (Table XIV)

This is a *japonica* variety. Such varieties are said to be non-sensitive to length of day in Malaya. However , the results are given, as there is apparently a difference in time to flowering between the North and South of the country. All sowings noted were made at the beginning of the month, but tests have only been made in the North and South latitude regions. Harvest data is missing for the South records.

Table XIV

Relation of Sowing Date and Latitude to Time to flowering and Harvest (in days) for Taichu 65

Latitude Group	Time to	Month of Sowing											
		Jan.	Feb.	Mar.	Apr,	May	June	July	Aug.	Sep.	Oct,	Nov.	Dec.
South	Flowering	—	114	106	107	—	98	102	100	103	114	118	—
North	Flowering	96	—	—	99	95	90	98	94	95	98	100	103
	Harvest	130	—	—	141	145	132	139	127	129	136	134	139

A. The Place of Latitude and Sowing Date in the Control of Flowering.

The results presented above do not give a complete record of the times to flowering (ear emergence) and maturation to be expected at all sowing dates and in all latitudes. They do, however, indicate to some extent the complex interelations which exist between ear emergence and length of day.

The results presented, which cover varieties with widely different maturation periods, show a distinct effect of latitude. In all the varieties grown in both the North and South regions the time from sowing to flowering is greater in the South than in the North of the country. In general the time from sowing to harvest, where available, also shows the same trend. Data from intermediate regions, as is to be expected, falls in most cases between that for the North and South regions. Departures from this general trend to show increasing maturation periods the further south the rice is sown are found in the varieties Anak Naga and Mayang Sa Gumpal. In Anak Naga, the time between sowing and flowering follows the trend for sowings made between July and December, but departs from it for sowings made during the rest of the year. The results from the south, however, represent only one experiment and are not complete, and therefore must be considered to need confirmation. With Mayang Sa Gumpal, whilst the time between sowing and harvest shows the latitude trend, the time recorded between sowing and flowering for the South Central is less than in both the North and the South regions. The South latitude region data confirms the trend for three out of the four months for which there are records.

A notable feature of this series of results, which might explain the discrepancy, is the very long time lapse between flowering and harvest The records available were inadequate to confirm if this was a real or spurious observation. Comparison with other records obtained from the South Central region suggest that the long time lapse noted is due to an error in recording. Further discussion of the reliability of results is given below.

As the tables given show, many more varieties have been tested in a single latitude region than have been tested in all latitude regions. This applies also to the reported variety trials (Larter, 5, 6.) where some varieties never appear to have been tested outside the area from which they originated. This may well mean that Larter's classification of varieties into long, long-medium, and so on may be somewhat incorrect, simply because the variety has never been properly tested or examined in another region. Thus for example Siam (Table II) sown on September 1st in the north reaches maturity some 164 days after sowing, and would be regarded as having a medium to short medium term maturation period, whereas in the south, Siam 29 sown on the same date matures in about 180 to 190 days, and could be recorded as a long-medium term variety. Some varieties, for example Radin Siak 34, will not differ very

FIG. I

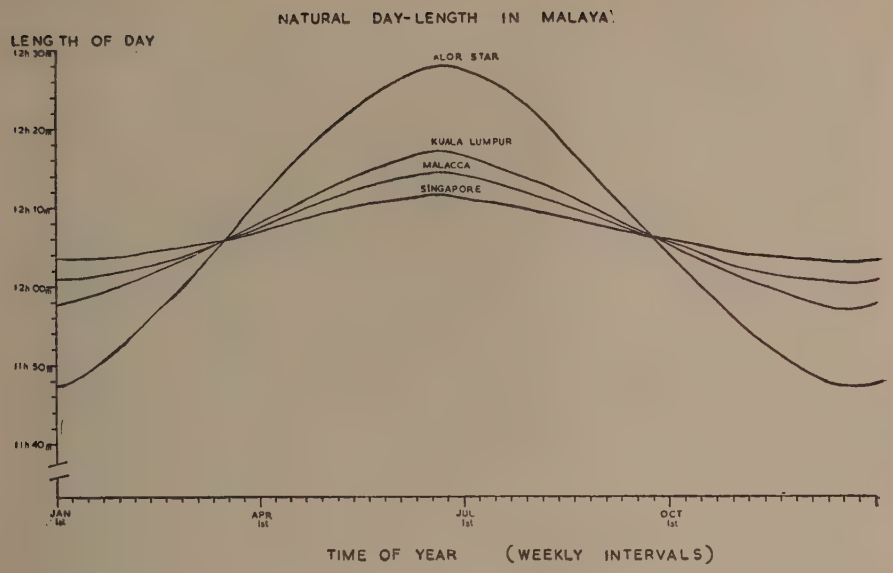
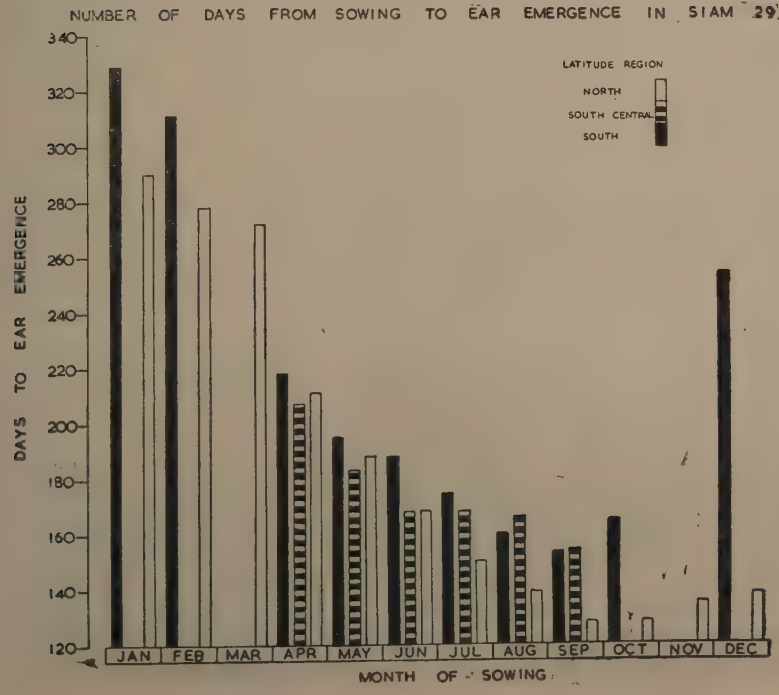

NATURAL DAY-LENGTH IN MALAYA
LENGTH OF DAY
ALOR STAR
KUALA LUMPUR
MALACCA
SINGAPORE
JAN 1st
APR 1st
JUL 1st
OCT 1st
TIME OF YEAR (WEEKLY INTERVALS)

FIG. II


NUMBER OF DAYS FROM SOWING TO EAR EMERGENCE IN SIAM 29
LATITUDE REGION
NORTH
SOUTH CENTRAL
SOUTH
DAYS TO EAR EMERGENCE
340
320
300
280
260
240
220
200
180
160
140
120
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
MONTH OF SOWING

much over the whole of the Federation, in which case the classification used will be correct.

Differences in the usual sowing dates between different regions may also give rise to misclassifications. Thus if a variety normally sown in June or July is compared with another variety from another area normally sown in September, they may be classified as of different maturation period groups, when in reality they may be of the same group. This has happened with Mayang Sa Gumpal (Larter, 5) which is classified as a long term variety, because it has normally been sown in June or July. If, however, it is sown in September in the North of the Federation, its maturation period is that of a medium-term maturation period variety (see Table III). Larter, (5) claims the varieties he has tested to be in general of very restricted adaptability. The question posed by the results presented here is: how much is the restricted adaptability due to day length, which is real and cannot be altered, and how much is due to physio-ecological cause, which can presumably be modified or altered? The answer to this question lies outside the scope of this paper and will not be considered.

The second and more obvious effect shown by records is that of month of sowing. In both the North and South the minimum time to flowering is found for sowings between August and October (with ocassional exceptions from November sowings). There is also a difference in the month of sowing which gives the longest time to ear emergence and harvest. This tends to be one or two months later in the North than in the South for the same variety. In Acheh Puteh, Radin Siak 34 and Siam 29 the maximum time to flowering (ear emergence) and harvest is found for January or February sowings in the North, and for December or January sowings in the South. Examination of the other results recorded, whilst incomplete, suggest that the lag between North and South also arises in these varieties. A similar lag is not apparent for sowings made during August to October, when the time to flowering recorded is a minimum. Examination of the data for varieties grown only in one region seems to confirm that maximum time to ear emergence and harvest occur in later sowings in the North than in the South.

A possible explanation of this curious interaction between sowing date and latitude can be obtained from a study of the length of day in any given latitude for any given sowing date. (Figure I should be referred to). In the North (Alor Star) a plant sown in December will receive through the months of December to Ferbuary sufficient short-days to induce flowering. A plant sown in the South in the same month will not only receive longer short-days, but will receive fewer of them. It will therefore not receive sufficient short-days to induce flowering in a short time unless it is planted earlier. In the North it is not until sowings are made in January or February that the plant will receive insufficient short-days to induce early ear emergence. The differences

in varietal behaviour will be due to the fact that flowering in some plants will be promoted by days of shorter length than in others.

In the response of rice to sowing date it is not the length of day at sowing which is important, but the number of inductive short days (i.e. days of sufficiently short length) which the plant receives.

Two further small points presented in the results given above require brief mention.

Yield data has been obtained for some sowings of Mayang Sa Gumpal, Radin Siak 34, and Siam 29. In Mayang Sa Gumpal no trend is apparent, in Radin Siak 34 it appears that the later a sowing in the season the higher the yield, whilst the data for Siam 29 indicates the reverse. The results available are too few to enable any general conclusion to be drawn. An obvious gap in the data needs to be filled here by further experimentation.

For Radin Siak 34 and Siam 29 data is available from experiments carried out in the South Central latitude region for sowings made with different nursery periods. In Radin Siak 34 nursery periods of 5 to 10 days (Table VII), 40 days (Table VI) and more than 45 days (Table VIII) are recorded. For a sowing made in April the respective times to flowering and harvest for each nursery are; for a 5 to 10 days nursery flowering in 124 days and harvest in 161 days, for a 40 day nursery flowering in 161 days and harvest in 204 days, and for a nursery of more than 45 days flowering takes place in 154 days and harvest in 202 days. The May, June and July sowings show the same trend. In Siam 29, plants receiving only a 5 to 10 day nursery (Table XII) similarly flower and mature earlier than corresponding sowings having a 40 day nursery (Table XI and Figure II). These general results confirm the data reported by Brown (1), that a longer nursery period delays flowering.

B. Varieties tested only in the North latitude region of the Federation.

Records are available for 28 varieties which have been tested for response to sowing date in the North latitude group. Table XV summarises the relation of sowing date to time to ear emergence and Table XVI the relation of sowing date to time to harvest. All the records are for varieties having a nursery period of 40 days. The data recorded covers varieties ranging from highly sensitive varieties with a difference between maximum and minimum time to ear emergence of up to 205 days (Arohan) to almost non-sensitive varieties with a difference in maximum and minimum times to flowering as small as 37 days (Jarum).

The minimum maturation period of the varieties bears no relatior to their photosensitivity, thus Arohan which is highly photosensitive has a minimum maturation period (Table XVI) which classifies it according to Larter's classification (5) as a medium term maturation period variety, whilst Jarum Mas, with a difference between minimum and maximum times to flowering of 65 days is also classifiable as a medium term variety.

Those varieties listed which are highly sensitive to sowing date all have maximum maturation periods when sown between December and March. The majority give maximum times to harvest when sown in January or February.

Eighteen of the twenty-eight varieties have a minimum maturation period when sown in October, whilst a further seven have a minimum maturation period when sown in November. The remaining three varieties give a minimum maturation period when sown in August and September.

It would be interesting if all these varieties could be tested in other latitude regions to see if they behave similarly to those varieties which have been tested both in the north and the south of the Federation.

Table XV

Relation of Sowing Date to Time to Flowering in Rice Varieties grown in the North Latitude Region. Nursery 40 days in all cases.

Variety	Month of Sowing. All sowings on 1st of Month.											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Anak Ikan Gresing	138	245	226	—	179	156	135	119	113	102	110	111
Anak Ikan Rendah	267	248	237	160	182	158	136	125	118	116	119	162
Anak Ikan Tinggi	—	210	234	212	187	166	151	136	125	122	130	135
Anak Puteh	298	296	271	—	207	203	161	146	139	136	144	147
Arohan	342	300	287	241	217	186	174	150	137	140	157	150
Chemara 9	113	157	152	143	129	132	123	124	116	113	120	115
Chempaka	142	135	168	134	146	132	126	119	136	118	119	122
Gading	270	237	258	223	201	182	175	148	141	134	144	148
Jambak	268	242	237	219	210	185	160	153	141	134	144	173
Mayang Batil	302	280	—	212	207	188	166	154	146	131	150	170
Jambu Merah	124	226	213	166	160	136	116	106	106	102	96	106
Jambu Puteh	146	252	224	173	172	148	128	116	113	104	103	110
Jarum	131	134	151	130	152	132	134	123	128	122	114	129
Jarum Mas	270	284	256	220	212	182	162	150	138	129	135	186
Jintan Pa'mat	—	—	—	164	163	135	118	112	118	100	92	—
Jintan Pasir	—	—	—	215	200	178	154	144	135	130	134	311
Jintan Petani	118	120	130	123	140	121	118	112	116	113	110	116
Jintan Puteh	299	250	256	215	206	190	171	148	141	128	130	155
Kedah	224	290	—	232	208	182	162	148	133	136	141	146
Kuntum Chempaka	133	132	158	144	154	140	134	122	130	128	122	138
Lembut Jabi	304	288	213	212	208	175	158	145	145	138	130	158
Melor 154	—	306	280	242	218	190	174	150	144	124	150	147
Melor	142	168	174	166	144	124	136	127	124	140	130	126
Morak Sepilai	319	306	287	241	218	201	177	156	144	146	157	159
Nalong	234	246	—	—	211	186	170	152	136	139	150	143
Neli 81	307	296	265	—	204	182	162	145	124	121	131	142
Serendah	148	307	274	243	222	195	180	156	142	148	148	149
Siak	310	281	—	215	204	178	154	139	138	127	134	148

Table XVI

Relation of Sowing Date to Time to Harvest in Rice Varieties grown in the North Latitude Region. Nursery 40 days in all cases.

Variety	Month of sowing. All sowings on 1st of Month.											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Anak Ikan Gresing -	203	279	269	—	209	184	166	149	149	139	144	148
Anak Ikan Rendah -	305	296	281	198	220	198	181	170	158	156	156	196
Anak Ikan Tinggi -	—	248	245	239	219	194	181	173	165	158	164	171
Anak Puteh -	332	331	311	—	231	214	203	180	176	169	179	177
Arohan -	358	336	232	259	242	218	204	188	176	173	193	167
Chemara 9 -	178	206	186	185	164	163	157	153	149	146	156	152
Chempaka -	166	188	219	179	196	190	176	168	164	168	178	178
Gading -	317	289	296	259	259	238	218	190	178	171	191	183
Jambak -	305	295	281	257	257	239	218	192	178	171	192	210
Jambu Merah -	175	266	252	211	210	183	159	149	148	144	131	148
Jambu Puteh -	192	296	272	211	208	180	175	156	151	144	133	150
Jarum -	176	181	202	185	197	174	171	164	170	157	154	161
Jarum Mas -	316	322	296	254	250	228	205	191	176	164	175	245
Jintan Pa'mat -	—	—	—	196	196	179	164	151	155	140	126	—
Jintan Pasir -	—	—	—	243	239	215	196	182	176	166	177	338
Jintan Petani -	163	164	184	166	176	166	170	154	155	152	150	160
Jintan Puteh -	339	308	296	254	250	226	208	191	182	169	178	201
Kedah -	263	315	—	257	234	212	201	180	168	173	176	178
Kuntum Chempaka -	183	240	228	182	188	177	178	172	174	162	168	180
Lembut Jabi -	346	319	264	248	242	220	208	190	180	176	176	210
Mayang Batil -	351	319	—	248	235	226	210	192	183	176	187	198
Melor 154 -	—	340	325	268	250	222	207	185	176	161	182	180
Melor -	182	205	194	199	173	167	166	154	161	170	167	167
Morak Sepilai -	337	339	325	363	250	235	210	193	180	178	179	182
Nalong -	268	281	—	—	238	216	199	186	173	173	182	183
Neli -	342	327	304	—	228	214	193	178	166	155	169	170
Serendah -	179	348	326	266	248	234	213	196	175	177	175	177
Siak -	351	322	—	249	242	220	201	186	178	162	178	188

C. Varieties tested in the South Latitude region of the Federation.

Fewer completed results are available from this region than for the northern latitude region. Table XVII gives the data for time from sowing to flowering for varieties tested in this region, whilst Table XVIII records the times to harvest for those of the varieties for which reliable data are available. (See comments on the reliability of data given below). In all cases the nursery period was 40 days, and sowings were made at the beginning of the month. An interesting record is that the wild rice species *Oryza fatua*, is shown to be only slightly photosensitive. The minimum time from sowing to flowering (Table XVII) for those varieties where a complete years observations are available is for September sowings. This is a month earlier than for varieties sown in the North. Most of the varieties have only been tested for sowings from April to September. It can be seen however that the results recorded

follow the trend shown by varieties for which a full year's records are available. That is, that the earlier sowings give the longest times to ear emergence. Data for time to harvest is missing in many cases, for some varieties no such data was available, whilst for other varieties it was not considered reliable (see below).

Further comments on these results will be given at the end of this paper.

Table XVII

Relation of Sowing Date to Time to Flowering in Rice Varieties grown in the South Latitude Region. Nursery 40 days in all cases.

Variety	Month of Sowing											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec,
Oryza fatua -	—	155	157	132	—	148	155	143	142	127	136	—
Banyak Anak -	—	—	—	199	167	166	158	140	136	—	—	—
Bongor -	273	247	—	202	180	162	—	128	124	131	—	—
Bujang Berinai -	—	—	—	230	199	181	178	160	—	—	—	—
Chantek (1296) -	—	202	179	178	—	196	181	177	171	156	—	—
Daron -	—	—	—	—	169	151	147	146	144	150	126	122
Haji Haroun -	135	217	—	183	143	153	128	—	108	109	120	116
Hitam -	—	—	—	198	174	159	151	140	133	—	—	—
Jambak Manik -	—	—	—	204	176	160	152	154	140	—	—	—
Kampar -	—	—	—	208	184	168	160	—	135	—	—	—
Kepayang -	—	—	—	216	176	170	164	150	144	—	—	—
Kontor -	—	—	283	—	194	199	197	163	159	—	—	—
Kuatek -	—	—	—	189	161	151	144	136	132	—	—	—
Machang -	—	—	320	312	259	251	251	210	204	—	—	—
Mayang Ebos 80 -	—	—	262	233	193	183	169	152	144	170	193	324
Mayang Ebos 88 -	—	—	—	182	—	196	182	179	169	160	156	—
Mayang Sa Batil -	—	—	—	—	259	228	245	216	191	—	—	—
Milek Kuning -	—	208	—	208	180	187	170	160	157	157	165	—
Milek Puteh 9 -	—	—	—	216	184	167	166	138	135	—	—	—
Nachin 11 -	—	292	—	206	200	184	176	162	158	—	—	238
Nachin Kuning -	—	—	—	225	186	164	158	150	145	152	—	—
Nachin Puteh -	—	—	—	—	188	165	155	148	147	152	—	—
Nachin 5057 -	—	—	183	189	—	183	177	162	163	156	—	—
Norin 20 -	—	110	118	115	—	94	98	90	108	104	100	—
Radin Che Ali -	—	—	181	183	—	187	189	176	169	165	—	—
Radin Che Mah -	—	204	181	200	168	180	165	158	151	160	—	—
Radin China 4 -	350	319	291	244	230	205	187	178	161	191	190	—
Radin China 17 -	—	—	—	208	175	170	160	156	146	—	—	—
Radin Keling -	105	130	131	109	110	113	111	95	91	91	106	101
Reyong 6 -	359	—	—	190	203	181	164	144	136	158	152	158
Seraup Kedhil 36 -	350	311	299	260	236	219	221	194	189	—	—	—
Serendah Kuning -	—	292	—	199	185	166	162	146	145	164	172	259
Serendah Menangkabau	—	—	—	194	166	153	142	131	130	—	—	—
Serendah Puteh -	—	273	245	217	178	172	155	150	146	160	162	173
Serendah Salleh -	—	—	—	198	174	170	164	146	146	—	—	—
Seri Raja -	350	319	299	260	236	217	225	201	185	—	—	—
Subang Intan -	323	262	264	244	209	197	196	163	158	—	227	373
Sultan -	—	—	—	—	186	165	155	158	152	153	—	—
Tankai Rotan -	—	—	—	165	149	137	138	136	133	140	125	124

Table XVIII

Relation of Sowing Date to Time to Harvest (in days) in some Rice Varieties grown in the South Latitude Region.
Nursery 40 days in all cases.

Variety	Month of Sowing											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Daron -	—	—	—	—	193	202	172	173	178	—	149	141
Nachin Kuning -	—	—	—	—	227	222	177	174	179	—	—	—
Reyong 6 -	—	—	—	—	—	206	181	183	176	—	179	—
Serendah Kuning -	—	—	—	—	223	208	190	186	187	—	—	—
Serendah Menangkabau	—	—	—	236	205	192	194	—	—	—	—	—
Sultan -	—	—	—	—	230	231	190	186	188	—	—	—
Tankai Rotan -	—	—	—	—	195	182	174	170	144	149	142	141

D. VARIETIES GROWN IN THE SOUTH CENTRAL LATITUDE REGION OF THE FEDERATION.

Table XIX

Relation of Sowing Date to Time to Flowering in Days for some Rice Varieties grown in the South Central Latitude Region.
Nursery 40 days in all cases.

Variety	Month of Sowing											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Banyak Anak -	—	—	—	209	178	179	171	171	170	—	—	—
Bujang Berinai -	—	—	—	210	186	180	170	158	—	—	—	—
Daron -	—	—	—	186	174	—	159	150	153	—	—	—
Hitam -	—	—	—	197	176	170	170	169	—	—	—	—
Jambak Manik -	—	—	—	208	183	167	175	171	146	—	—	—
Kampar -	—	—	—	199	183	178	170	171	—	—	—	—
Kepayang -	—	—	—	204	184	171	172	171	—	—	—	—
Kuatek -	—	—	—	189	166	162	166	167	171	—	—	—
Milek Kuning -	—	—	—	205	188	175	176	180	—	—	—	—
Milek Puteh 9 -	—	—	—	211	182	181	176	172	—	—	—	—
Nachin Kuning -	—	—	—	212	184	170	173	178	—	—	—	—
Nachin 11 -	—	—	—	208	186	172	173	171	146	—	—	—
Radin Che Mah -	—	—	—	204	183	169	175	168	140	—	—	—
Radin China 4 -	—	—	—	208	183	174	169	157	144	—	—	—
Radin China 17 -	—	—	—	208	188	177	177	166	152	—	—	—
Reyong 20 -	—	—	—	198	181	169	172	170	161	—	—	—
Serayap -	—	—	—	161	147	150	148	157	152	—	—	—
Seraup Kechil -	—	—	—	212	196	185	178	185	—	—	—	—
Serendah Kuning -	—	—	—	201	188	179	166	157	158	161	—	—
Serendah Menangkabau	—	—	—	196	175	164	165	160	154	—	—	—
Serendah Puteh -	—	—	—	208	190	176	178	185	170	—	—	—
Serendah Salleh -	—	—	—	204	178	182	170	—	150	—	—	—
Siam (5) -	—	—	—	168	169	147	155	161	158	—	—	—
Tanakai Rotan -	—	—	—	158	140	138	149	157	149	—	—	—
Terong Papan -	—	—	—	198	179	171	173	179	—	—	—	—

Table XX

Relation of Sowing Date to Time to Harvest (in days) for some Rice Varieties grown in the South Central Latitude Region. Nursery 40 days in all cases.

Variety	Month of Sowing											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Banyak Anak	—	—	—	248	223	211	205	213	—	—	—	—
Bujang Berinai	—	—	—	249	226	218	214	—	—	—	—	—
Hitam	—	—	—	242	215	211	205	218	—	—	—	—
Jambak Manik	—	—	—	244	208	209	207	—	—	—	—	—
Kampar	—	—	—	252	215	208	207	—	—	—	—	—
Kepayang	—	—	—	244	214	206	211	215	—	—	—	—
Kuatek	—	—	—	230	202	193	186	197	—	—	—	—
Milek Kuning	—	—	—	244	211	214	207	213	—	—	—	—
Milek Puteh 9	—	—	—	250	215	213	211	216	—	—	—	—
Nachin Kuning	—	—	—	250	218	206	210	217	—	—	—	—
Nachin 11	—	—	—	248	217	212	212	216	—	—	—	—
Radin Che Mah	—	—	—	246	216	210	209	—	—	—	—	—
Radin China 4	—	—	—	253	218	213	211	213	—	—	—	—
Radin China 17	—	—	—	248	217	208	213	218	—	—	—	—
Serayap	—	—	—	208	181	191	175	189	—	—	—	—
Seraup Kechil	—	—	—	251	226	222	220	218	—	—	—	—
Serendah Kuning	—	—	—	245	228	222	210	209	182	198	—	—
Serendah Menangkabau	—	—	—	234	206	202	194	200	—	—	—	—
Serendah Puteh	—	—	—	247	218	208	208	213	—	—	—	—
Serendah Salleh	—	—	—	255	218	216	206	—	—	—	—	—
Tankai Rotal	—	—	—	200	—	182	180	—	—	—	—	—
Terong Papan	—	—	—	242	204	201	206	213	—	—	—	—

Many of the varieties tested in the South region (see C above) have also been tested in the South Central latitude region. Unfortunately in no case is a full annual record available. Table XIX gives the time from sowing to flowering, and Table XX the time from sowing to harvest. Nurseries were, in all cases, of 40 days duration. The results show that the general trend established for other regions applies also in this region. The general reliability of these results, however, is probably less than for other regions. For example, the data for June sowings tend to be low, and do not fit with the established trend to show a decreasing time between sowing and flowering or harvest. The harvest times recorded are also of doubtful validity.

E. Varieties grown in the South Central Region of the Federation with a Short Nursery Period.

Four varieties, including one non-sensitive Japonica type (Pebefun) have been grown in this region in addition to those recorded in sections A and D above. The nursery period used for these varieties was from 5 to 10 days. The results are not therefore comparable with those from other regions.

The varieties were sown both at the beginning and in the middle of the month but, as differences between these two occasions within the month did not on examination appear important, the data from any one month has been averaged. It can be seen that the sensitive varieties follow the established trend, maximum times to flowering and harvest being obtained with sowings made in February and March, and minimum times for sowings made in August and September.

Table XXI

Relation of Sowing Date to Time to Flowering and Harvest (in days) for some Rice Varieties grown in the South Central Latitude Region. Nursery 5 to 10 days in all cases.

Variety	Time to	Month of Sowing											
		Jan.	Feb.	Mar.	Apr,	May	June	July	Aug.	Sep.	Oct,	Nov.	Dec.
Nachin 11	Flowering	150	202	182	172	166	151	134	128	130	128	125	125
	Harvest	157	236	218	215	205	190	172	160	157	—	157	159
Pebefun	Flowering	83	76	74	77	79	75	78	76	79	78	83	—
	Harvest	115	104	102	117	112	113	115	115	112	112	112	—
Seraup Kechil 36	Flowering	140	—	198	183	166	157	149	142	140	136	134	139
	Harvest	172	—	229	217	208	199	184	174	171	173	168	170
Serendah Kuning	Flowering	158	156	184	186	167	153	142	134	131	132	133	133
	Harvest	—	—	220	221	202	188	177	164	160	162	163	165

The Reliability of the Data Recorded

It has been indicated above that some of the data collated here cannot be regarded as being an accurate representation of results which will be obtained in any repetition of these experiments. This unreliable data can serve only as a guide to trends which might be expected in practice.

In general, data for the time from sowing to harvest shows greater variability than the data for the corresponding time to flowering. The reasons for this are twofold. Firstly, climate conditions, rainfall and flooding, for example, and pest damage, are more likely to influence the speed at which the grain ripens than they are likely to influence the photoperiodically induced flowering process. Thus ripening and drying off of the grain for harvest would be delayed by excessive rainfall after flowering in a wet year, whereas in an exceptionally dry year the grains might not reach their full size, but would dry out and apparently be ripe earlier than in an average year. Secondly, there are those differences

due to the observer. The author has himself seen grain harvested whilst the tillers are still green. Such differences in date of harvest have arisen in the past because there is no established method of determining the state of ripeness of the grain.

Flowering, which is generally recorded as the date when 50 per cent of the ears have emerged, is also liable to be wrongly recorded. Climatic conditions have not been observed to delay ear emergence in experiments carried out under laboratory conditions in Kuala Lumpur, and it seems unlikely that climate will cause more than a few days delay under field conditions. Extensive damage by stem borer, on the other hand, can cause misrecording of date of 50 per cent flowering, for a late borer attack can completely inhibit ear emergence. Thus, although the anatomical changes associated with flower formation have taken place, no visible record is obtained. In these results, wherever the records have indicated extensive stem borer damage, they have not been summarised. Probably the greatest error in recording 50 per cent flowering is that due to errors of observation. General practice is not to count tillers but to make a visual estimate of the date of 50 per cent flowering. As however for most sowing dates the duration of emergence is only a few days, the errors here are less than for harvest data. There is no indication, for the large majority of experiments summarised here, that errors of the type outlined above have led to anything more than a few days difference. In most cases the uniformity of data available from several years observations and several sites provides sufficient check on the reliability.

In one particular case however, namely for some records from the South Central region, (Section D above.) the author has grave doubts as to the reliability of the results. The data for these results comes entirely from two sites in Negri Sembilan, from experiments over which the author exercised no supervision. The doubt arises only from the internal evidence provided by the records themselves. These doubts are: First, the apparent discrepant result for the June sowings. Secondly, the long time lapse between flowering and harvest recorded for many of the varieties in some sowings. Such a long time lapse does not agree with the authors personal experience. Thirdly, the records for date of harvest show a number of varieties of widely differing characteristics to have been harvested on exactly the same day. Not only varieties from the same month of sowing, but in some cases varieties from different months of sowing have been harvested on or about the same day. Whilst it is theoretically possible for a given variety grown in two different months to be harvested on the same day, it is extremely unlikely for a number of varieties to behave in this way unless they were all of the same or similar type. Fourthly, the differences between successive years are much greater than similar annual differences obtained from other regions. It is not possible from the records to decide whether the date of harvest was determined by climatic considerations (e.g. onset of the wet season, or imminence of floods, or pest damage) or whether it was

due to errors of observation. The long delay between flowering and harvest recorded in the earlier sowings in this region suggests that these sowings were over-ripe when harvested. Some of the results from the South region, which also come from a site in Negri Sembilan are also open to the same criticism. These doubtful results are those for which sowings were made only between April and September.

The possibility of there being gross inaccuracies in the results from the South Central region does not wholly invalidate the results, as there is no reason to suppose that great inaccuracies have been made in the record of flowering. It is also appears possible that the inaccurately recorded harvests are confined to the sowings made in April, May and June in the South Central latitude group.

General Discussion and Summary

Photosensitivity in Malaya

The natural day to day variation in the number of hours of day light in Malaya (Fig. 1) is very small. The variation between one month and the next is also small. It is as small as three minutes per month in the North latitude group and proportionally less in the latitude groups further south. Rice sowing date experiments carried out in other countries have been noted by Gangulee (3) who has drawn attention to the characteristic behaviour of monthly sowings of rice. The experiments reported here show that Malayan rice varieties also have the same characteristic response to day length. Sowings made between December and March can be expected to give very long times to ear emergence, whilst those sowings made between August and October give the minimum times to ear emergence.

Attention has rarely been drawn to the fact that the large differences in time to ear emergence or maturation in rice can be induced by very small differences in natural day length, or that the differences in length of day due to one or two degrees difference in latitude can also effect the time of ear emergence and maturation. I have, however, drawn attention to the effect of very small differences of length of day on the time to ear emergence elsewhere (Dore, 2). The data given here serves to reinforce the conclusions previously drawn.

It is unfortunate that insufficient yield data is available to enable any conclusions to be drawn as to the interrelation between the length of time a plant is growing and its yield. This forms one of the gaps in the data which it would be advantageous to fill, for if by sowing rice in the month which gives the shortest time to maturation it could be shown that yield was in no way decreased, it would make it possible to plant two annual crops of rice in many areas where this is not at present done because of the long maturation periods normally found in these areas . Obviously climatic conditions, especially the availability of water and the onset of a rainy season, many be such as to make it impossible to sow the rice in the month which induces the shortest time to

maturation. However, further experimentation to test all varieties in all latitude regions for all dates might well show that many varieties are more adaptable to different areas than is at present realised.

Acknowledgements

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OBSERVATIONS ON THE GROWTH-RATE OF THE CHINESE GRASS CARP, *CTENOPHARYNGODON IDELLUS* C. et V.

BY

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Introduction

The Chinese Grass Carp is one of the most important fishes which are reared in ponds for human consumption. Gidumal (1) writes "as the grass carp grows rapidly it is comparatively inexpensive to rear, and so provides a rich cheap source of protein for the population" and describes it as a popular fish in south-east Asia. It is extensively cultivated in Malaya and Singapore (2), as well as in Borneo, Indonesia, Thailand, the Indo-China succession states, Taiwan, Hongkong, and the Phillippines. It is cultivated on a great scale in ponds in China itself (3).

More recently, it has become established in Japan, and is breeding there on a small scale. But the main breeding places are in the West River of China, and this is the source of the fry which are bought for commercial stocking. Lin (4) describes the methods of capture and sorting of the fry.

Although it is such an important fish, there seems to be little detailed information in the literature as to its rate of growth under known conditions. Lin (loc. cit.) states that the following lengths and weights are reached in the periods stated, in the fish-ponds in Hong-kong.

	First Year	Second Year	Third Year	Fourth Year
Length	1-3 in	12-15 in	24 in	50 in
Weight *	¼ katty	2 katties	4-5 katties	7-10 katties

But, he says, the fish "are kept in nursery ponds in a very crowded condition for the first year. If, for example, the fry of the grass carp are reared from the beginning in large ponds, with comparatively few numbers, they will reach a size weighing at least 1½ to 2 katties (2 to 2.7 lb.) when they are only eight months old. Generally speaking, the growth of the pond-fishes is influenced by several factors, the most important of which are the food, the space, the temperature of the water."

Gidumal (1) writes: "Under normal healthy conditions, the grass carp that hatch in April may reach 10 inches in length and 1¼ lb. in weight in one year. At the end of the second year they may weigh 4-5 lb. A mature carp of four years old is usually well over 10 lb. in weight."

Lin (5) states that most of the fish caught on the natural spawning ground at Sunchow, on the West River, are four years old, and weigh from 7 to 10 katties. None of the mature grass carp recorded, either

* NOTE: 1 katty = 1⅓ lb.

male or female, weighed less than 6 katties (8 lb.) or was younger than three years.

Grass Carp at the Malacca Station

The two cultures of grass carp here described were bought in March and July, 1958, respectively. As the spawning season of this fish is during the period April to August, the first culture must have been nearly a year old at the time of purchase, while the second probably came from the current season's spawning. But both lots were of the usual merchantable size for fingerlings, namely, from about 5.5 to 7.0 cm. The fry dealers, as is well-known, are able to keep their fingerlings on a subsistence ration for many months, so that they do not exceed the merchantable size. Though the two cultures, in July, 1958, had only four months difference in the period of stocking, they were, in fact, about 15 and 3 months old respectively.

Temperatures

The temperature of the ponds at the Malacca Station shows no significant seasonal variation; the diurnal variation is from about 28°C. to 31°C. Probably, a temperature of 29.5° C would represent a fair average.

Discussion of Data in Table I

By comparison with commercial fishponds, the rate of stocking in these experiments was light. Lin (4) gives examples of the rates of stocking in commercial fishponds in Hong-Kong. The grass carp may be stocked at a rate of 100, 50, or 40 fish per mow, that is, at about 250, 125, or 100 fish per half-acre. Culture II came nearest to the lowest rate quoted by Lin, and the Table shows that this culture grew to an average weight of 3.31 kg (say 7.2 lb, or 5.5 katties) in 267 days.

Though Culture I was stocked at only about half the rate of Culture II, the observed rate of growth was slower. It will be seen that Culture I reached a mean weight of 2 kg in 254 days. Culture II in 204 days.

The use of the means may be misleading, for there is little doubt that the males of the grass carp grow more slowly than the females, as in other Cyprinids, and this leads to a wide spread of the weight frequencies. It should therefore be said that no fewer than 11 of the fish in Culture I were heavier than 5 kg (11 lb.) only 413 days after stocking, while four out of nineteen fish sampled in Culture II had passed 3.5 kg in 267 days. Few fish can have a faster rate of growth than this. (Plate I).

The half-acre ponds in which the grass carp were grown, or into which they were transplanted, had a natural growth of the aquatic phanerogam *Enhydrias angustipetala,* and it was seen that the fish were feeding on this. So the growth was stimulated by dressings of basic

PLATE I

FISH PLATE

Chinese grass carp (male), 75 cm. long, weighing 5.5 kg. (approximately 12 lb.); 500 days from stocking as 6 cm. fingerling.

Table I

The Data.

Date	Numbers stocked or surviving	Days	Size of Pond	Fertiliser used	pH	Food daily (Napier grass) lb.	Sampling Method	No. of Fish Examined	Mean	
									L. cm.	Wt. Kg.
CULTURE I										
25/ 3/58	103	—	½ ac.	1 ton cowdung 7 kg ammophos, 17 kg K Cl 30 lb. basic slag.	7.1	—	—	10	5.8	.002
4/12/58	58	254	½ ac.	—	7.3	about 120 lb daily from 1/10/58.	Fished out	58	55.3	2.00
12/ 5/59	58	413	½ ac.	80 lb.basic slag.	—	about 200 lb. daily	Fished out	58	65.1	4.24
CULTURE II										
31/ 7/58	140	—	½ ac.	Ca CO_3 40 lb.basic slag. 4 kg urea 3 kg K Cl	6.7 8.0	—	—	—	5.8	.002
8/10/58	106	69	¼ ac.	4 kg urea 3 kg K Cl 4 kg ammophos	6.7	—	Fished out	11	20.5	.0972
23/10/58	—	84	½ ac.	25 kg ammophos 30 kg K Cl 60 lb.basic slag.	6.9 7.3	—	Dead Fish	1	27	.25
7/11/58	—	98	—	—	—	—	Dead Fish	4	31.2	.36
25/12/58	—	146	—	—	—	—	Dead Fish	1	40	.73
20/ 2/59	93	204	½ ac.	—	—	—	Fished out	49	53.8	2.00
24/ 4/59	93	267	½ ac.	80 lb.basic slag.	7.8	about 180 lb. daily	Seine haul	19	63.1	3.31

The "dead fish" referred to above were those found dead after heavy rain (see Birtwistle (2)).

slag, muriate of potash, and some ammophos. About two acres of waste land were planted with Napier grass, and this was cut daily for feeding to the fish. It was noticed, however, that the fish preferred the Napier grass, and that when excess of grass was supplied, the Enhydrias multiplied anew.

The grass carp consumed very large quantities of Napier grass. For example, during the period 20/2/59 to 24/4/59, the two cultures were being fed some 350 lb. per day on six days per week, or about 19,000 lb. during the period. During this time they put on a total weight of about 390 lb. As they preferred the grass to the Enhydrias, it can be suggested that they were converting Napier grass into fish at a rate, in excess of their maintenance requirements, of about 48 lb. of grass to one pound of fish. But the fish fed on the leaves only, leaving the stalks, so that the conversion rate for the leaves would be somewhat better, probably from 35 to 40 lb. of leaves to one pound of fish, in excess of maintenance requirements. The leaves of Napier grass are rather fibrous, and a better conversion rate would probably be got from softer grasses.

But the high yield of Napier grass per acre, and the ease of cutting, would seem to make it worth a fish-farmer's while to plant this grass on waste ground near his ponds.

The Condition of the Fish

Ti Chow (6) has worked out the length-weight relation in a culture of grass carp in Hong-Kong. In Table II below, the weights of the Malacca fish of Culture II, as on 24/4/59, are compared with those of the Hong-Kong fish.

Table II

Length (cm)	Weight Malacca (kg)	Weight Hong-Kong (kg) Observed	Calculated
57	2.3	1.89	2.08
58	2.8	2.36	2.19
61	2.95	—	2.57
62	3.30	—	2.70
63	3.46	3.15	2.84
64	3.43	2.95	2.98
66	3.50	3.30	3.50
65	3.70 ,,	—	3.30

It will be seen that, in spite of their very rapid growth, the condition of the Malacca fish was not inferior to that of the Hong-Kong fish.

Summary

The observed rates of growth of two cultures of grass carp (*Ctenopharyngodon idellus* C. et V.), under stated conditions, at the Fish Culture Research Station, Malacca, are given. From fingerlings

stocked at a weight of 2 gm., they grew to an average weight of 3310 gm. in 267 days (Culture II), and 4240 gm. in 413 days (Culture I). The maximum weights were 3500 and 5450 gm. respectively. The conditions of temperature, density of stocking, and feeding, are given.

It seems that this fish converts about 48 lb. of Napier grass into one pound of fish, in excess of maintenance requirements. The rate of growth is very fast, and can be exceeded by few, if any, other species of fish.

In spite of this rapid rate of growth, the condition of the fish in these cultures was not inferior to that of a culture reported in Hong-Kong, with which it is compared.

Literature Consulted

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(3) Hoffmann W.E. "Preliminary Notes on the Freshwater Fish Industry of South China." *Lingnan Univ. Sci. Bull. No. 5*, Canton, 1934.

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(5) ibid. "Life-History of Waan Ue, *Ctenopharyngodon idellus* C. et V" *Lingnan Sci. Journ.*, Vol. 14, No. 1, 1935.

(6) Ti Chow. "Growth Characteristics of Four Species of Pondfish in Hong Kong." *Hong Kong University Fisheries Journal* No. 2 pp. 29-36, September, 1958.

NOTES ON CURRENT INVESTIGATIONS

January to June, 1960

Weather

Weather conditions during the period were generally dry with occasional light showers. This dry sunny weather was ideal for ripening padi and harvesting.

Padi

CROP REPORT

Wet Padi

Harvesting of wet padi from the 1959/60 main season had almost been completed by the end of the period. Approximately 846,500 acres had been harvested by the end of May from a planted acreage of 862,000. This is an all time record.

The production of wet padi in the 1959 off-season and the 1959/60 main season is the highest ever achieved in the Federation of Malaya. A yield of more than 350 million gantangs has been obtained, equivalent to over 850,000 tons of padi or 530,000 tons of milled rice. This represents an increase of nearly 29 per cent over the average for the previous decade and two-thirds as much again as the production in the decade prior to the war. Further, it shows an increase of more than 12 per cent over that achieved in the bumper harvest of 1957/58.

The significant increase in production in the past year has been due partly to an increase in acreage but mainly to an increase in the yield obtained per acre. The present acreage of wet padi of both off and main season crops is the highest ever recorded, exceeding the prewar average by 28 per cent and the average for the previous decade by six per cent. The weather in the past season has also been kind and the acreage of padi destroyed by flood, drought, pests and disease in only 7,520 providing an unequalled record of 874,000 acres harvested.

The significant feature of acreage returns for the past season has been the substantial increase in yield per acre. An average of 392 gantangs has been achieved from the harvested acreage, an increase of 22 per cent over the average for the past decade and 10 per cent over that obtained in the 1957/58 record season. However, it is important to recall that it is this constituent of yield increase which is most susceptible to the vagaries of the weather as exemplified by the reduction in yield in the 1958/59 season.

The following table outlines in summary the figures of the production of padi in the 1959/60 season relative to pre and post-war average. For the purpose of comparison, yield is quoted per acre of land planted.

It is of interest to note that over 15 per cent of the increase in acreage since the 1957/58 bumper harvest is due to an increase in the land being double-cropped. The area double-cropped in 1959 was 50 per cent greater than that in 1958 and the yield for the off-season crop

was 422 gantangs per acre, an increase of 5 per cent over that obtained in 1958.

Wet Padi Production, Main and Off-Season Crops

Period	Planted Area (acres)	Harvested Area (acres)	Total Production (Gantangs)	Yield in Gantangs per acre	
				Harvested	Planted
1959/60	881,200	873,700	342,407,000	392	389
10-year Average Pre-war 1931/32 to 1940/41	688,500	N.A. *	205,092,000	N.A. *	298
10-year Average Post-war 1949/50 to 1958/59	832,400	813,400	266,310,000	327	320
1957/58 Bumper Season	857,500	850,200	304,605,000	358	355
1959 season as percentage of:					
Pre-war average	128	— *	167	— *	131
Post-war average	106	107	129	120	122
1957/58 Bumper Season	103	103	112	109	110

NOTE: * Not available; harvested area statistics not collected prior to 1947/48 season.

In Province Wellesley, Kedah, Kelantan and Trengganu planting of off season padi was completed during the period. There has been a further increase in the acreage of double-cropped land, and in Province Wellesley alone the introduction of double-cropping in the Muda river irrigation scheme has increased the double-crop acreage from 9,850 in 1959 to 17,250 this season.

Harvesting commenced in Province Wellesley North late in the period. Yields from 225 acres harvested produced an average yield of 490 gantangs per acre. Cultivations for the main season crop began in north Malaya in early May. Progress was well in hand by the end of the quarter and transplanting was due to commence in some areas. A great deal of attention is being paid this year to driving home the importance of husbandry techniques. Coupled with this, padi fertiliser recommendations have been revised and technical assistance provided to the Department of Co-operative Development in a scheme to provide fertiliser on credit. An independent scheme has been sponsored by the Department of Agriculture to encourage further the use of nursery fertiliser; the economic benefits of this practice having been widely demonstrated.

Dry Padi

Harvesting of both upland and lowland dry padi has been completed, save for relatively small areas in Trengganu and Negri Sembilan. Out of a total of 61,200 acres planted 59,800 acres has been harvested, i.e. approximately 98 per cent. An average yield of 213 gantangs per acre has been obtained.

The combined yield of rice from both the dry and wet padi crops during the past year represents over 68 per cent of estimated national consumption.

RESEARCH AND SELECTION

Tank Experiments

All the tank experiments were concluded and the tanks were taken over by F.A.O. expert Dr. Matsushima for his work on water—plant relationships. The results of the various tank experiments can be summarised as follows:—

(a) BRIS SOIL. On the bris, nitrogen and phosphate are absolutely necessary. A small amount of green matter (leaves) (about three tons dry) added with about six cwt. lime per acre, three weeks before transplanting, in addition to nitrogen and phosphate added as usual, would improve yields considerably. Split dressings of nitrogen fertiliser are better, as the sand is not retentive of nitrogen.

(b) INLAND ALLUVIUM, BATU KIKIR N.S. Nitrogen and phosphate are both essential, and for really high yields about six tons to the acre of green matter, with half a ton of lime added three weeks before transplanting, in addition to nitrogen and phosphate, seems to be necessary. Application of fertiliser to the off-season crop gives a small increase in yield to the subsequent main padi crop.

(c) GELAM SOILS. Plants on gelam soils require lime and fertilisers not containing sulphate. Drainage is of great importance and cultivation helps to oxidise the sulphide and distribute the lime more evenly in the root zone of the plants.

Variety Trials completed in 1960

P. 380 "Nachin Selections" Tangkak P.T.S., Johore

After four years' trial, no strain has been found to give more than the control, Nachin 11. Strain No. 39, recommended for the Malacca coastal area, did consistently well.

P. 358 "Local Varieties versus Serendah Kuning" at Kerdau P.T.S., Pahang.

After four years' trial it has been demonstrated that Serendah Kuning will probably give better yields in this area than the local Pahang varieties.

"Seraup Selections", Krian P.T.S., Perak

At the conclusion of these trials, after three years, the superiority of S.50 as an adaptable high yielding strain for Krian has been confirmed. Further south at Talang P.T.S., in Central Perak, strain No. S.27 gave the highest yield.

Introduced Varieties in Trengganu

Trials which are now terminated after only two seasons have confirmed that Morak Sepilai, at Gerai in the north, and Lembu Basah, at Gelugor in the south, are among the best long-term varieties for planting in Trengganu.

The trial of short term varieties showed that Acheh Puteh is probably the best of these for the area but it was out-yielded by Siam 29, which gave almost 3,400 lb./acre.

EXPERIMENT TO CONTROL STEM BORERS

Judging from the yield, it appears that Dipterex emulsion at 400 gm. a.i. per acre and BHC emulsion at 306 gm. a.i. per acre produced significant increases in yield; BHC w.p. at 275 gm. a.i. per acre and BHC dust at 360 gm. a.i. per acre were ineffective against the pest.

The physical conditions of the padi fields in Krian allows the use of power sprayers for application of insecticides:—

No. of men required to operate machine		3	
Rate of application	....	1	acre per hour
Output of chemical	....	6	gal. per minute
Petrol consumption	....	¼	gal. per hour

AGRONOMIC INVESTIGATIONS AND EXTENSION

Investigations conducted by the Colombo Plan Team have supported previous findings and have shown that techniques of applying fertiliser are of greater immediate importance than determination of the actual nutrient requirements of the crop in any particular area. The results of trials conducted at Bukit Merah Padi Experiment Station, Province Wellesley, suggest that while yield responses to application of both N and K are noticeable this is not the case with phosphate. This, however, may be a reflection of heavy dressings in earlier years.

Furnace slag imported from Japan and containing substantial quantities of CaO and S_1O_2, a certain amount of MgO and sometimes Fe_2O_3, Al_2O_3 and MnO has not influenced yield when applied as a pre-transplanting dressing.

In Kelantan results of manurial observations for 30 out of 261 sites were obtained from Tumpat District. The summary is as follows:—

East Coast mixture	....	460	gantangs/acre
Federal mixture	....	405	„ „
Co-operative mixture	....	450	„ „
Control	....	360	„ „

Results from other districts are expected to follow the same pattern. It was generally observed so far that the co-operative mixture which gave the most rapid recovery and vigorous growth of padi did not produce to any degree the expected yield superiority. In Negri Sembilan manurial observation using same basal dressings with urea and sulphate of ammonia as top dressing gave superior yield per acre where urea was used as top dressing:—

Basal Dressing	*Top Dressing*	*Yield/acre*
A. Mixture 1	Urea	532.5 gantangs
1	S/Ammonia	350.8 „
B. Mixture 2	Urea	512.5 „
2	S/Ammonia	396.7 „
C. Mixture 3	Urea	417.0 „
3	S/Ammonia	346.7 „

Results of other padi investigations which were carried out during the season 1959/60 had not been completely analysed but examination of a summary of the results of trials revealed a certain amount of interesting information.

In the trial to determine the comparative economic effects of using overage seedlings and seedlings of a shorter term variety, transplanted at an optimum stage of development, it was observed at Telok Chengai that the medium term variety, Radin China, planted 70 days old gave some 240 lb. per acre more than the short term variety, Radin Kling, which was planted later at the optimum age. Significant differences in yield could, however, be seen within the Radin China variety planted at different ages at the same spacing of 12″ x 12″. The calculated yields per acre of 30, 50 and 70 day old seedlings are 3,913, 3,519 and 2,648 respectively.

An examination of the results of the type of phosphate experiment from Kedah indicated that fused magnesium phosphate at 60 lb. P_2O_5 per acre gave 230 lb. per acre more yield than similar amount of Christmas Island rock phosphate. In Trengganu, on the other hand, Christmas Island rock phosphate appeared to give higher yield than similar amount of double superphosphate or fused magnesium phosphate.

Observation on nitrogen slow release had shown that prawn dust and dried blood were superior to NPK standard. The prawn dust and dried blood gave 280 lb. and 250 lb. per acre more yield than the standard NPK mixture. In the rate of N application observation in Kedah the response to N had shown progressively increasing yield up to 60 lb. nitrogen—the highest level being tried. The highest level N tried, however, is below the level where the law of diminishing returns begins to operate. Observations on the effect of yield of padi on the varying rate and frequency of application of nitrogen fertiliser indicated that with medium term padi the best result was, from yield and economy of application, obtained from splitting N into three equal parts and applying each part as base, five weeks after planting and eight weeks after

planting. It was found there was no significant difference between type of N used in two different forms of urea—prilled and coated—compared with sulphate of ammonia, in the exepriment to ascertain their effects on growth and yield of padi.

Following the results of application of lime on gelam soil in Malacca, observations on liming were carried out in many areas of the country. From the results obtained so far it would appear not all soil types would give increase in yield due to lime. In fact, in Tallang, the application of lime resulted in decrease in yield. Also in a number of areas lime at two tons per acre produced small increase over control but gave lower yield than those treatments limed at one ton per acre. It was seen that areas that showed response to lime were those that contained a high percentage of organic matter. Probably, beside reducing acidity and supplying exchangeable calcium to those areas, lime helped in the breakdown of organic matter resulting in the liberation of otherwise unavailable plant food.

Rubber

In the first quarter, distribution of rubber planting materials to rubber smallholders amounted to 40,191 yards of budwood and 838,919 clonal stumps, as compared with 52,864 yards of budwood and 800,000 clonal stumps distributed during the same period last year. Progress in new planting scheme was reported to be satisfactory.

In the second quarter, distribution of rubber planting material to smallholders for both new planting and replanting amounted to 76,872 yards budwood and 891,650 clonal seedling stumps. The increased distribution during the last quarter is partly seasonal but it is significant that the yardage of budwood distributed is much greater than was the case a year ago. It has become apparent during the quarter that the demand for rubber budwood in the current season is likely to outstrip supply, furthermore there is increasing evidence that in many cases State Governments have proceeded with land development programmes without making provision for rubber budwood and it is anticipated that the already serious shortage will become acute in 1961. Remedial action has been initiated, but as the task is likely to exceed the limited resources of the Department, it has been agreed by the Board of the R.I.S.P.M. that further expansion in budwood production will be undertaken by a separate authority. The Department of Agriculture will slowly withdraw from its function as a producer of rubber budwood and will finally surrender its responsibility in about seven years time.

Progress in new planting schemes is reported to be reasonably satisfactory. However, the increasing shortage of budwood is gradually being appreciated and in some of the newer schemes budwood nurseries are being established.

Coconut

There was a small drop in the price of copra during the January-March quarter. For estate copra the price ranged between $36 and

$41.50 per pikul and smallholders copra fetched between $30 and $36 per pikul. In general, the price of smallholders copra was better than that obtained throughout the last quarter.

Falling prices continued during the second quarter. Estate copra fetched between $27 and $32 a pikul, while the price of smallholder copra varied widely arount a mean of $23 to $28 per pikul. The yield in many areas increased by about ten per cent; however in Malacca, a drop in yield has been reported.

On the 'bris' soil organic manure placed in the planting holes continued to produce markedly healthy growth of young palms. Interplanting of stylosanthes between coconuts had also shown an effect of soil amelioration of this legume by the healthy appearance of the palms as compared with areas where grass is used as a cover.

Rhinoceros beetle continues to be a major problem, although no increase in the incidence of the pest has been reported. During the quarter the beetle *'Oryctes rhinoceros'* has been gazetted as a dangerous pest. This action will empower inspecting officers to ensure that eradication of breeding places is properly effected and should go a long way towards bringing the pest under control.

Steps are now being taken to introduce *Scoliid* wasps to control *Oryctes* on coconuts.

Coffee

During the first quarter, the outbreak of hawk moth, *Cephonodes hylas* L. spread into three areas from the original area in Selangor. Organized control measures using four swing fogs and 25 per cent miscible DDT was implemented. The affected areas were mapped and a leaflet on control measures was printed for distribution to the farmers.

The outbreak of hawk moth in the Ulu Langat district continued to spread during the second quarter from Bukit Cheeding to Kampong Labohan, Dagang, Bukit Changgang and Olah Lampit. Organised control measures brought the pest under control.

Interest in further expansion in the acreage of this crop is centred mainly in Selangor and Johore. In the latter State a further two mills have been opened to process the increasing production of berries.

The prevailing dealers price of dried Liberica coffee bean in Klang varied between $135/- and $145/- per pikul during January to March. Fresh berries were sold to dealers in Selangor at $3.80 per kerosene tin full. These prices were somewhat reduced from those of the last quarter. Small scale planting continued in all parts of the Federation.

The price of dried Liberian coffee beans at Klang fell to $120 per pikul towards the end of the second quarter, a drop of between $15 and $25 a pikul.

Fruit

Fruit of many types has been in season during the second quarter. Dry weather during the first quarter influenced fruit set and this is

reflected in the somewhat mediocre harvest obtained. Fruiting in Kedah and Perlis was light and in Penang it was the poorest for many years. In contrast with this a good season was experienced in Perak with the rest of the country having a mediocre crop. Fruit prices varied throughout the country but a fairly good average was maintained.

The increase of foot rot and collar rot in citrus is reaching serious proportions. The disease is particularly serious in the Telok Anson district of Lower Perak, the Subang district of Selangor and the Segamat district of Johore. Demonstration of prophylactic and curative measures are in hand but the only long term answer is the selection and production of resistant material either as rootstocks or as acceptable varieties.

A small peak harvest of pineapple occurred in Johore in May to June. Nearly two thousand tons of fruit were sold to the canneries by the Pekan Nanas Co-operative Society and a similar quantity was sold through middlemen. The same co-operative sold 72 tons of urea to its members, but this may prove to have been undesirable, as nitrogenous fertiliser is capable of producing the full expression of its value on peat soil only in the presence of adequate supplies of potash.

Grape vines obtained from Vietnam and planted at the Federal Experiment Station, Cameron Highlands, are growing vigorously and show promise. In the lowlands at the Federal Experiment Station, Serdang, leaf eating pests are proving to be a problem.

In Johore, egg-laying cicadas caused considerable damage to rambutan branches by killing the branch from the point of egg insertion upwards. As a precautionary measure, spraying with dieldrin was suggested if cicadas were seen again in the area.

Tea

Progress continues to be made in the establishment of blocks of clonal tea at both the Federal Experiment Stations, Serdang, and Cameron Highlands. At Serdang, some of the clones are yielding the equivalent of 3,000 lb. of made tea per acre per annum.

A trial at Federal Experiment Station, Cameron Highlands, designed to test the effect on yield of several levels of nitrogenous manuring has given most promising results. Nitrogen is applied at the rate of 0, 40 lb., 80 lb. and 120 lb. of nutrient per acre. All treatments receive a base dressing of 30 lb./acre each of P_2O_5 and K_2O. The figures in the following table show the marked response to nitrogen:—

Calculated Mean Yields of Made Tea

(lb. per acre for the entire second 3 year cycle)

Treatment	Yield/Acre	Increase over Control
N_0 No nitrogenous fertiliser	2358	—
N_1 40 lb. Nitrogen/acre/annum	2948	590
N_2 80 lb. Nitrogen/acre/annum	3607	1249
N_3 120 lb. Nitrogen/acre/annum	4187	1829

If a conservative estimate is made that the profit to the grower from each pound of tea is normally 30 cents, then it may be calculated that in this trial the outlay of each additional dollar on fertilizer has resulted in a minimum additional net income of three dollars.

Interesting results were forthcoming from a NPK 2^3 factorial trial also at the Federal Experiment Station, Cameron Highlands. Examination of yield data from the second cycle of this trial, which was terminated inE 1959, indicate that there is less response to N and P applied separately than was the case in the first cycle. uhen these nutrients are applied in conjunction, however, the yield of leaf increases markedly. There would seem also to be a slight response to application of potash and this feature is being closely watched in the third cycle.

Cacao

Incidence of leaf yellowing and die-back at the Federal Experiment Station, Jerangau, Trengganu, increased early in the year. This was anticipated in view of the monsoon rain being heavier than in the previous year. The correlation between rainfall and severity of symptom seems to follow a reasonably clear pattern and manuring schedules have been amended appropriately.

Tobacco

Harvesting of Virginia tobacco from an experimental project on 50 acres of smallholdings in Kelantan, organized by the Malayan Tobacco Company, has been completed. 10,000 lb. of cured leaf has been produced but only 40 per cent of this was considered to be of reasonable quality. Showery weather at harvest was responsible for the poor quality of much of the leaf, and the company considers the results to be sufficiently encouraging to extend the pilot project next season.

Pastures and Fodders

Examination of the results of long term fodder grass manurial and variety trials at the Federal Experiment Station, Serdang, show that yields of guinea grass were increased from an average of 27 tons per year to an average of 42 tons per year over a three year period as a result of applying combined N and K fertiliser. Cattle manure similarly increased yields by 41 tons per acre per year. The response in both cases was linear over two increments and the interaction was significant and produced a further yield increase of eight tons per acre per annum. The overall yield pattern showed the expected linear decline from the first to third year. However, the effect of cattle manure increased yield slightly from the first to the third year.

In a guinea grass variety trial several strains from East Africa have outyielded the local material, although in some cases the food value of the grass is comparatively poor. The most promising variety is Tanganyika (short) which is both high yielding and produces material of high food value. Both this variety and the local strain are consistently late flowering.

Vegetables

The potato variety Van Haeringen 52-03 has again yielded very well at F.E.S. Cameron Highlands. This variety has proved to be highly resistant to blight (*Phytophtera infestans*) and has yielded over eight tons of tubers per acre from once grown seed. Cooking and eating tests indicate that the quality of this variety is good. A repeat trial is to be laid down in due course to obtain information on the performance of twice grown seed.

Numerous varieties of vegetables obtained from Japan, India and the U.S.A. have been tested in the lowlands and Highlands. The most promising are some American lettuce varieties. In the case of all other types of vegetable no variety proved to be better than those in normal use.

The use of prawn dust as a vegetable manure at Cameron Highlands is traditional practice; but prawn dust attracts flies and is thereby a danger to health. A long term trial to find prawn dust substitutes at the Federal Experiment Station, Cameron Highlands, has indicated over six cropping cycles that mixtures containing either been cake or Sterameal Black Label, supplemented with inorganics, are capable of maintaining or even increasing yields. This evidence is further confirmed by results obtained in 1959 and it is reasonable to conclude that the use of prawn dust as a manure can be discontinued and the farming community can be invited to use substitute mixtures, which are both cheaper than prawn dust and—in the case of the mixtures based on Sterameal Black Label—less of a liability to the health of the community.

In a potato time of planting observation it was seen that crop planted in January gave a better yield than crops planted in February or March. Comparative figures on yield of crop planted in January, February and March are 11,088 kts., 5,643 kts. and 891 kts. per acre respectively.

Tomato and Potato Late Blight

The third fungicide trial incorporating dithiocarbamate fungicide was completed in the first quarter and results were received recently. Tritoftoral (Zineb : zinc ethylene bis dithiocarbamate) and Tricarbamix special (mixture of zineb, maneb and ferbam) have fared very well in the trials. Maneb (Manganese ethylene bis dithiocarbamate) has proved just as efficient as Bordeaux mixture in controlling late blight.

The results of the trials are as follows:—

Tomato

March 1958: Tritoftorol gave significantly better yields than Bordeaux mixture, Duphar Colloidal Copper and Flit 406.

June 1959: Tritoftorol and Tricarbamix special gave significantly better yields than Trimangol and Bordeaux mixture.

1959—60: No significant difference between treatments.

POTATO

June 1959: Tritoftorol and Tricarbamix special gave significantly better yields than Trimangol, Bordeaux mixture and the control.

1959—60: Tritoftorol and Tricarbamix special gave significantly better yields than Trimangol, Bordeaux mixture and the control.

TOMATO

Total Yield of Healthy Fruit (in pounds from Six Plots)

	June, 1959	1959/60
Bordeaux mixture	25.25	97.2
Tricarbamix special	111.75	94.4
Trimangol	11.50	130.4
Tritoftorol	110.50	163.3

POTATO

Total Yield of Healthy Fruit (in pounds from Six Plots)

	June, 1959	1959/60
Control	3.75	33.25
Bordeaux mixture	38.75	83.00
Tricarbamix special	84.50	133.50
Trimangol	34.25	98.50
Tritoftorol	73.00	125.25

It was found at Cameron Highlands that Tritoftorol has proved to be effective for potato blight. The strength used was 5 gm. per litre of water.

Soil Survey

In order to determine how representative the soils on the present Agricultural Stations are of the soils in the areas which they serve, soil examinations were made of all Agricultural Stations in the country which grow crops other than padi. The soils on 43 such stations were examined and classified, 25 of these stations were found to be sited on alluvial soils, five on a mixture of both alluvial and sedentary soils, and 13 only were sited wholly on sedentary soils. It is probable that the greater proportion of crops, other than padi, are grown on sedentary soils and this proportion will certainly rise in the future, as the main reserves of suitable land for agricultural development are to be found in

inland areas where sedentary soils are most common. It therefore appears that the present distribution of dryland crop stations is not sufficiently representative of the soils in the developed district which they should serve, and in view of the very wide variation in sedentary soils in different parts of this country a very strong case can be made out for increasing the number of dryland crop stations on sedentary soils, and possibly also reducing the number of such stations on alluvial soils. The broad scale Schematic-Reconnaissance soils survey programme at present being undertaken by the soil survey unit is indicating which stations are most truely representative of the areas which they serve, and is also pin-pointing the areas which are not adequately served by the present agricultural stations.

Field work in the soil survey of the rice growing areas of the Kedah Coastal Plain was completed during February. Sites were suggested for small stations on each of the main soil types and bulk samples of the main soils were taken for pot experiments which will be carried out in Kuala Lumpur. An Information Department photographer took some photographs for use in illustrating the final bulletin on the "Soils of the Kedah Coastal Plain" which it is hoped to produce in 1961.

STAFF NOTES

(Period 1st January to 30th June, 1960)

Promotions

		w.e.f.
Mohamad bin Jamil .... (Agricultural Officer)	Senior Agricultural Officer, Headquarters. (Grade A)	4.2.60
G. F. Darnell .... (Agricultural Officer)	Senior Agricultural Officer, Selangor, (Grade A)	4.3.60
J. S. Ure .... (Senior Agricultural Officer, Grade A)	Asst. Director (Field) and to	23.4.60
	Dy. Director of Agriculture	12.6.60

Appointments

Ani bin Arope	Agronomist	17.3.60
Tengku Mansur bin Tengku Ja'acob	Agricultural Officer	23.4.60
Lim Chin Lam	Chemist	18.5.60
N. Thirunavukarasu	Botanist	21.5.60

Transfers and Postings

R.J.R. Barrett .... (Agronomist)	Senior Agricultural Officer, Pahang. Grade A (Acting)	12.3.60
Khalid bin Abdul Rahman .... (Senior Lecturer)	Senior Agricultural Officer, Negri Sembilan	14.3.60
Omar bin Buyong .... (Senior Agricultural Officer, Pahang, Acting)	Senior Agricultural Officer, Perak, Grade A (Acting)	4.4.60
Lee Sin Fook .... (Agronomist)	Senior Agricultural Officer, Penang and Province Wellesley	1.5.60
G. I. M. Martin .... (Agronomist)	Senior Agricultural Officer, Kedah. Grade A (Acting)	10.6.60
J. S. Ure .... (Deputy Director)	Director of Agriculture (Acting)	12.6.60
Mohamad bin Jamil .... (Senior Agricultural Officer, Headquarters)	Deputy Director (Acting)	12.6.60
C. Whitehead .... (Senior Agronomist)	Asst. Director (Field) (Acting)	12.6.60
Ahmad bin Mohamad Amin .... (Agricultural Officer)	Senior Agronomist (Acting)	12.6.60

		w.e.f.
Wan Mohamad Don bin Mohamad .... (Agricultural Officer)	Senior Agricultural Officer, Perlis	13.6.60

Leave

G. W. Arnott .... (Senior Chemist)	On long leave	10.5.60

Retirements

The following officers proceeded on leave prior to retirement under the Tenth Schedule to the Federation of Malaya Agreement (Amendment No. 4) Ordinance, 1956.

T. R. Dickinson .... (Senior Agricultural Officer, Grade A)	Assistant Director (Field) (Acting)	4.2.60
H. D. Matheson .... (Senior Agricultural Officer, Grade A)	Senior Agricultural Officer, Selangor	4.3.60
G. S. Keeping .... (Asst. Director (Field))	Deputy Director (Acting)	20.4.60
J. L. B. Hitchcock .... (Senior Agricultural Officer, Grade A)	Senior Agricultural Officer, Kedah	9.6.60
A. L. Barcroft .... (Dy. Director of Agriculture)	Director of Agriculture (Acting)	10.6.60
J. A. Cox	Agricultural Development Officer, Headquarters	30.6.60

Resignation

K. T. Joseph .... (Soils Chemist)	Resigned on joining the staff of the University of Malaya, Kuala Lumpur.	1.2.60

October to December, 1959 & January to March, 1960

Rubber.—The price rose from 104 cents per pound at the beginning of the period and remained well above the dollar level. The average price in cents per pound, f.o.b., as quoted by the Singapore Chamber of Commerce Rubber Association was as follows:—October 104.92, November 127.08, December 117.07, January (1960) 114.11, February 115.12 and March 119.05.

Palm Oil.—Palm oil production during the period was well maintained and for the first quarter of 1960 exceeded the total for the same period in 1959 by nearly 4,000 tons (see Table V).

Agricultural Exports.—Attention is drawn to a change in the method of compiling figures for Table VIII. The figures for 1959 do not include exports from Singapore.

Table I

AVERAGE MONTHLY PRICES PAID BY LOCAL DEALERS FOR SMALLHOLDERS' RUBBER, OCTOBER TO DECEMBER, 1959, AND JANUARY TO JUNE, 1960.

(dollars per pikul*)

	Alor Star, Kedah			Negri Sembilan Seremban,			Johore Bahru, Johore		
1959	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.
Smoked Sheet No. 1	116.72	140.29	122.94	116.14	134.74	122.51	115.69	136.38	122.70
No. 3	113.25	128.90	118.69	112.57	125.46	119.51	113.23	127.89	120.52
1960	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.
Smoked Sheet No. 1	118.39	119.20	123.25	119.42	120.91	124.36	119.03	120.40	123.90
No. 3	116.11	116.94	118.25	117.66	118.49	119.22	117.56	118.40	119.17
1960	April	May	June	April	May	June	April	May	June
No. 1	123.16	132.90	126.43	124.64	132.15	127.66	123.75	131.83	125.79
No. 3	116.49	117.64	117.74	117.84	117.79	119.91	117.55	118.28	118.95

* 1 pikul = 133⅓ lb.

This table has been compiled from statistics supplied by the Chief Statistician, Federation of Malaya.

Table II
RUBBER PRODUCTION FEDERATION OF MALAYA
(long tons, dry weight)

Month	Estates		Smallholdings (Estimated)		Total	
	1959	1960	1959	1960	1959	1960
January -	37,600	37,400	27,200	27,400	64,800	64,800
February -	27,900	31,800	21,200	22,500	49,100	54,300
March -	28,500	29,900	21,100	24,800	49,600	54,700
April -	28,800	28,000	19,300	19,000	48,100	47,000
May -	33,500	33,000	22,300	24,000	55,800	57,000
June -	33,800	34,000	24,200	24,000	58,000	58,000
July -	35,600		26,700		62,300	
August -	36,400		24,700		61,100	
September -	35,600		25,900		61,500	
October -	35,900		25,300		61,200	
November -	35,600		23,900		59,500	
December -	38,500		26,600		65,000	
Total -	407,700		288,400		696,100	
Total 1958 -	390,200		271,500		661,300	

This table has been compiled from statistics published by the Chief Statistician, Federation of Malaya.
Production on smallholdings (estates of less than 100 acres) is taken as the total of purchases from smallholders reported by licensed dealers.

Table III
AVERAGE PRICES PAID IN LONDON FOR TEA
(s.d. per lb.)

For the Week Ending	Malayan		Ceylon		Indonesian		India				African	
							Northern		Southern			
	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
8-1-60	4	4.61	4	9.05	Nil		4	7.62	4	3.40	4	4.27
15-1-60	4	3.59	4	7.90	Nil		4	5.98	4	3.61	4	3.61
22-1-60	4	2.29	4	6.97	4	6.13	4	5.88	4	3.75	4	3.17
29-1-60	4	5.01	4	6.92	Nil		4	5.73	4	3.98	4	3.23
5-2-60	4	6.10	4	6.75	Nil		4	4.65	4	2.34	4	0.55
12-2-60	4	2.40	4	6.44	Nil		4	4.68	4	1.16	4	2.34
19-2-60	4	2.35	4	6.29	Nil		4	5.03	4	1.11	4	1.13
26-2-60	3	11.67	4	7.07	Nil		4	5.20	4	1.35	4	0.53
4-3-60	4	2.37	4	6.87	Nil		4	5.07	4	1.60	3	11.27
11-3-60	3	10.77	4	7.96	Nil		4	4.34	4	1.50	3	10.44
18-3-60	3	10.87	4	8.24	Nil		4	3.54	4	1.56	3	10.53
25-3-60	3	10.09	4	6.95	Nil		4	0.67	3	11.66	3	7.32
1-4-60	3	7.38	4	3.61	Nil		3	11.46	3	8.07	3	3.80
8-4-60	3	7.82	4	4.33	Nil		4	0.49	3	8.83	3	4.77
14-4-60	3	4.48	4	4.89	Nil		4	1.19	3	9.45	3	4.88
29-4-60	3	5.80	4	6.01	Nil		4	2.12	3	10.33	3	4.18
6-5-60	3	6.94	4	6.49	Nil		4	3.72	3	10.13	3	4.04
13-5-60	3	9.80	4	5.89	Nil		4	4.24	3	9.95	3	3.97
20-5-60	3	9.05	4	5.70	Nil		4	4.34	3	10.24	3	3.89
27-5-60	3	9.42	4	5.87	Nil		4	4.65	3	10.55	3	2.51
3-6-60	3	8.47	4	5.98	Nil		4	3.36	3	8.97	3	1.14
17-6-60	3	5.54	4	5.20	3	8.73	4	1.85	3	8.10	3	2.36
24-6-60	3	11.36	4	4.72	Nil		4	4.45	3	8.80	3	2.33

Table IV

AVERAGE DEALERS' PRICES FOR DRIED LIBERICAN COFFEE BEANS GROWN IN SELANGOR*

(dollars per pikul †)

For the Week Ending	Klang	Kuala Langat
	$	$
9-1-60	145.00	142.00
16-1-60	145.00	145.00
23-1-60	140.00	140.00
30-1-60	140.00	140.00
6-2-60	138.00	140.00
13-2-60	138.00	135.00
20-2-60	135.00	135.00
27-2-60	135.00	135.00
5-3-60	140.00	135.00
12-3-60	140.00	135.00
19-3-60	135.00	135.00
26-3-60	135.00	135.00
2-4-60	135.00	135.00
9-4-60	135.00	135.00
16-4-60	140.00	135.00
23-4-60	140.00	135.00
30-4-60	145.00	140.00
7-5-60	145.00	140.00
14-5-60	145.00	140.00
21-5-60	135.00	135.00
28-5-60	130.00	125.00
4-6-60	130.00	125.00
11-6-60	130.00	125.00
18-6-60	130.00	125.00
25-6-60	125.00	125.00

* These are not the prices paid to smallholders, who sell freshly harvested berries to dealers for processing.

† 1 pikul = 133⅓ lb.

Table V

PRODUCTION OF PALM OIL AND KERNELS AND PRICES OF PALM OIL

(long tons, as declared by estates)

Month	Production of Palm Oil (long tons)		Production of Palm Kernels (long tons)		Average Price per Ton of Palm Oil *
	1959	1960	1959	1960	1960
					£ s. d.
January -	5,225	5,931	1,388	1,645	74 10 9
February -	4,824	7,232	1,356	2,012	75 10 3
March -	6,553	7,445	1,815	2,082	75 0 0
April -	5,268	7,638	1,404	2,030	74 11 2
May -	5,055	7,183	1,314	1,841	73 7 0
June -	5,931	9,127	1,565	2,352	71 4 2
July -	6,912		1,888		
August -	7,005		1,958		
September -	6,674		1,754		
October -	5,031		1,536		
November -	6,143		1,682		
December -	6,018		1,634		
Total -	71,541		19,294		

* F.O.B.

Table VI

PRODUCTION OF COPRA, COCONUT OIL AND COPRA CAKE
FEDERATION OF MALAYA

(tons)

Month	Copra Production						Coconut Oil Production *		Copra Cake (Poonac) Manufactured	
	Estates		Smallholdings (estimated)		Total		Oil Mills		Oil Mills	
	1959	1960	1959	1960	1959	1960	1959	1960	1959	1960
January	1,827	2,299	8,000	7,700	9,827	9,999	4,195	5,233	2,709	3,227
February	1,947	2,323	1,500	8,000	3,447	10,323	3,556	5,919	2,298	3,670
March	2,377	2,575	6,000	11,000	8,337	13,575	4,027	5,091	2,643	3,132
April	2,523	2,554	6,000	9,800	8,523	12,300	4,636	5,503	3,041	3,472
May	3,097	2,821	8,000	11,000	11,097	13,821	5,327	6,203	3,519	3,888
June	3,338	2,779	13,000	12,800	16,338	15,500	8,385	7,015	5,499	4,410
July	3,779		9,000		12,779		5,880		3,964	
August	3,445		9,000		12,445		7,343		4,734	
September	3,122		9,000		11,822		6,136		3,819	
October	2,622		8,700		11,622		5,608		3,570	
November	2,321		9,000		9,321		5,739		5,693	
December	2,681		7,000		8,681		6,340		3,999	
Total	33,079		91,200		124,239		67,162		43,488	

Notes:—1. The above table has been compiled from statistics published by the Chief Statistician, Federation of Malaya.

2. Estate copra production and coconut oil production are as declared by estates and oil mills, respectively.

3. Statistics of smallholding coconut oil production are not available.

4. Smallholding copra production for commercial purposes is estimated from the formula: imports + estate stocks (opening) + estate production + smallholding production = exports + local oil mill consumption + estate stocks (closing).

* Includes both refined and crude oil.

Table VII

SINGAPORE PRICES OF VARIOUS AGRICULTURAL PRODUCTS

(dollars per pikul †)

Date	Copra, Sundried	Coconut Oil *	Pepper, F.A.Q. Muntok White	Pepper, Gen. Muntok White	Gambier, Cube	Sago Flour, Lingga	Tapioca Flour No. 1	Oilcake, Round
4-1-60	40.00	64.00	351.00	361.00	46.00	8.62	17.00	17.00
11-1-60	41.00	64.50	501.00	511.00	46.00	8.62	17.00	18.00
18-1-60	41.25	65.50	441.00	451.00	46.00	8.62	17.00	18.00
25-1-60	41.50	65.00	421.00	431.00	46.00	8.50	17.00	18.00
1-2-60	41.75	65.00	426.00	435.00	46.00	8.50	17.00	18.00
8-2-60	41.75	65.00	401.00	411.00	46.00	8.50	17.00	16.50
15-2-60	41.25	65.00	351.00	361.00	46.00	8.62	17.00	16.50
29-2-60	41.25	65.00	376.00	386.00	46.00	8.62	17.00	16.50
7-3-60	40.75	63.00	331.00	341.00	46.00	8.62	17.00	16.00
14-3-60	39.75	62.75	321.00	331.00	46.00	8.50	16.50	16.00
21-3-60	39.00	60.50	301.00	311.00	46.00	8.62	16.50	15.75
29-3-60	38.75	60.75	371.00	381.00	46.00	8.50	16.00	15.75
4-4-60	38.75	61.00	321.00	311.50	46.00	8.62	16.00	15.50
11-4-60	37.50	58.00	321.00	331.00	46.00	8.50	16.00	14.50
19-4-60	36.50	58.00	321.00	331.00	46.00	8.62	16.00	14.50
25-4-60	35.00	56.25	321.00	331.00	46.00	8.50	15.00	14.00
3-5-60	36.00	57.75	301.00	311.00	46.00	8.50	15.00	14.00
9-5-60	34.75	56.00	280.00	290.00	46.00	8.37	15.00	14.50
16-5-60	33.75	57.50	266.00	276.00	46.00	8.50	15.00	14.50
23-5-60	33.50	54.00	256.00	266.00	43.00	8.62	15.00	14.50
30-5-60	32.75	52.50	266.00	276.00	42.00	8.75	14.50	14.50
6-6-60	30.50	50.75	266.00	276.00	46.00	8.62	15.50	14.00
13-6-60	29.50	46.50	290.00	300.00	41.00	8.75	15.50	14.00
20-6-60	30.00	49.00	311.00	321.00	42.00	8.75	14.00	14.00
27-6-60	30.00	48.00	305.00	315.00	45.00	8.75	14.00	15.00

† 1 pikul = 133⅓ lb.
* F.O.B. in second-hand drums.
‡ Nominal.
The above prices are taken from the weekly reports of the Singapore Chamber of Commerce.

Table VIII

MALAYAN AGRICULTURAL EXPORTS, JANUARY TO DECEMBER, 1959. ‡

Product	Net Exports in Tons			
	* Year 1956	* Year 1957	* Year 1958	Year 1959
Arecanuts	11,228	9,625	4,938	6,941
Coconuts, fresh †	34,779	37,466	52,340	104,935
Coconut oil	103,132	100,031	67,483	27,641
Palm Oil	55,252	56,728	67,818	71,103
Pineapples, canned	30,377	37,671	41,417	27,119
Sago, flour	21,483	15,581	21,652	681
Tapioca, flake	260	403	350	122
Tapioca, pearl	5,630	5,222	3,333	1,765

* Figures for 1956—58 include Singapore. † hundreds.
‡ Statistics compiled from "Federation of Malaya, Statistics of External Trade", December, 1959 (excluding Singapore).

FEDERATION OF MALAYA RICE STATISTICS

Summary of Acreage and Production, 1959/60 Season

WET PADI

State (1)	Area Planted (2)		Area Destroyed (3)		Area Harvested (4)		Average Yield per Acre			Production			Remarks (9)
							Padi (5)	% of Main Season Average Yield	Rice (6)	Padi (7)	% of total	Rice (8)	
	Acres	% of total	Acres	% of (2)	Acres	% of (2)	*Gtg.*		lb.	*Gtg.* ('000s)		Tons	
Perlis	63,130	7.3	—	—	63,130	100.0	483	123.5	1,704	30,503	9.0	48,040	
Kedah	281,330	32.4	710	.3	280,620	99.7	450	115.1	1,588	126,167	37.3	198,690	710 acres damaged by pest and disease.
Kelantan	159,180	18.3	2,680	1.7	156,500	98.3	321	82.1	1,132	50,181	14.9	79,020	2,680 acres destroyed by flood.
Trengganu	49,810	5.7	80	.2	49,730	99.8	276	70.6	974	13,727	4.1	21,620	80 acres damaged by flood and pest.
Penang and P. Wellesley	39,270	4.5	—	—	39,270	100.0	398	101.8	1,404	15,627	4.6	24,610	

Table VII

SINGAPORE PRICES OF VARIOUS AGRICULTURAL PRODUCTS

(dollars per pikul †)

Date	Copra, Sundried	Coconut Oil *	Pepper, F.A.Q. Muntok White	Pepper, Gen. Muntok White	Gambier, Cube	Sago Flour, Lingga	Tapioca Flour No. 1	Oilcake, Round
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25-1-60	41.50	65.00	421.00	431.00	46.00	8.50	17.00	18.00
1-2-60	41.75	65.00	426.00	435.00	46.00	8.50	17.00	18.00
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29-2-60	41.25	65.00	376.00	386.00	46.00	8.62	17.00	16.50
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23-5-60	33.50	54.00	256.00	266.00	43.00	8.62	15.00	14.50
30-5-60	32.75	52.50	266.00	276.00	42.00	8.75	14.50	14.50
6-6-60	30.50	50.75	266.00	276.00	46.00	8.62	15.50	14.00
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Tapioca, flake	260	403	350	122
Tapioca, pearl	5,630	5,222	3,333	1,765

* Figures for 1956—58 include Singapore. † hundreds.
‡ Statistics compiled from "Federation of Malaya, Statistics of External Trade", December, 1959 (excluding Singapore).

FEDERATION OF MALAYA RICE STATISTICS

Summary of Acreage and Production, 1959/60 Season

WET PADI

State (1)	Area Planted (2)		Area Destroyed (3)		Area Harvested (4)		Average Yield per Acre			Production			Remarks (9)
							Padi (5)	% of Main Season Average Yield	Rice (6)	Padi (7)	% of total	Rice (8)	
	Acres	% of total	Acres	% of (2)	Acres	% of (2)	*Gtg.*		lb.	*Gtg.* ('000s)		Tons	
Perlis	63,130	7.3	—	—	63,130	100.0	483	123.5	1,704	30,503	9.0	48,040	
Kedah	281,330	32.4	710	.3	280,620	99.7	450	115.1	1,588	126,167	37.3	198,690	710 acres damaged by pest and disease.
Kelantan	159,180	18.3	2,680	1.7	156,500	98.3	321	82.1	1,132	50,181	14.9	79,020	2,680 acres destroyed by flood.
Trengganu	49,810	5.7	80	.2	49,730	99.8	276	70.6	974	13,727	4.1	21,620	80 acres damaged by flood and pest.
Penang and P. Wellesley	39,270	4.5	—	—	39,270	100.0	398	101.8	1,404	15,627	4.6	24,610	
Perak	114,090	13.1	530	.5	113,560	99.5	352	90.0	1,242	39,960	11.8	62,930	480 acres destroyed by flood in Nov./Dec. 1959. 50 acres abandoned.
Selangor	48,960	5.6	30	.1	48,930	99.9	520	133.0	1,835	25,432	7.5	40,050	For 30 acres cultivation was a failure.
Pahang	41,530	4.8	20	—	41,510	100.0	225	57.5	794	9,326	2.8	14,690	20 acres destroyed by flood.
N. Sembilan	30,980	3.6	500	1.6	30,480	98.4	374	95.7	1,319	11,400	3.4	17,950	500 acres not harvested due to late planting and damage by pests.
Malacca	31,400	3.6	370	1.2	31,030	98.8	410	104.9	1,446	12,727	3.8	20,040	250 acres were not harvested due to late planting, drought and empty grain. 120 acres destroyed due to sea-water, flood, rats and other pests.
Johore	8,740	1.1	60	.7	8,680	99.3	308	78.0	1,087	2,676	.8	4,210	60 acres destroyed by birds, flood etc.
Total 1959-60 Season	868,420	100	4,980	.6	863,440	99.4	391	—	1,379	337,726	100	531,850	
Off-Season Crop 1959	11,640	—	30	.3	11,610	99.7	422	—	1,489	4,902	—	7,720	
Total 1959-60 Main and Off-Season Crops	880,060	—	5,010	.6	875,050	99.4	392	—	1,383	342,628	—	539,570	
Total 1958-59 Main and Off-Season Crops	867,770	—	41,870	4.8	825,900	95.2	327	—	1,154	270,034	—	425,250	

Acreage to nearest 10 acres.
Rice Production to nearest 10 tons.
Conversion Rates: 635 *gantangs* Padi = 1 ton rice.
1 *gantang* Padi = 5.6 lb. Padi.
1 *gantang* Padi = 3.528 lb. Rice (i.e. Milling recovery of 63 per cent).

FEDERATION OF MALAYA RICE STATISTICS

Summary of Acreage and Production, 1959/60 Season

DRY PADI (LOWLAND)

State (1)	Area Planted (2)		Area Destroyed (3)		Area Harvested (4)		Average Yield per Acre			Production			Remarks (9)
							Padi (5)	% of Main Season Average Yield	Rice (6)	Padi (7)	% of total	Rice (8)	
	Acres	% of total	Acres	% of (2)	Acres	% of (2)	*Gtg.*		lb.	*Gtg.* ('000s)		Tons	
Perlis	—	—	—	—	—	—	—	—	—	—	—	—	
Kedah	1,780	5.3	330	18.5	1,450	81.5	173	78.3	610	251	3.5	400	330 acres damaged by drought and pest.
Kelantan	20,120	59.9	20	.1	20,100	99.9	256	115.8	903	5,138	71.5	8,090	20 acres destroyed by flood.
Trengganu	9,080	27.0	700	7.7	8,380	92.3	172	77.8	607	1,438	20.1	2,260	700 acres damaged by flood and pest.
Penang and P. Wellesley	100	.3	—	—	100	100.0	200	90.5	706	20	.2	30	
Perak	1,260	3.7	—	—	1,260	100.0	160	72.4	564	201	2.8	320	
Selangor	—	—	—	—	—	—	—	—	—	—	—	—	
Pahang	1,250	3.7	—	—	1,250	100.0	111	50.2	392	139	1.9	220	
N. Sembilan	—	—	—	—	—	—	—	—	—	—	—	—	
Malacca	—	—	—	—	—	—	—	—	—	—	—	—	
Johore	20	.1	20	100.0	—	—	—	—	—	—	—	—	20 acres destroyed by flood.
Total 1959-60 Season	33,610	100	1,070	3.2	32,540	96.8	221	—	780	7,187	100	11,320	
Total 1958-59 Season	33,810	—	480	1.4	33,330	98.6	200	—	706	6,677	—	10,520	

Acreage to nearest 10 acres.
Rice Production to nearest 10 tons.
Conversion Rates: 635 *gantangs* Padi = 1 ton rice.
1 *gantang* Padi = 5.6 lb. Padi.
1 *gantang* Padi = 3.528 lb. Rice (i.e. Milling recovery of 63 per cent).

FEDERATION OF MALAYA RICE STATISTICS

Summary of Acreage and Production, 1959/60 Season

DRY PADI (UPLAND)

State (1)	Area Planted (2)		Area Destroyed (3)		Area Harvested (4)		Average Yield per Acre			Production			Remarks (9)
							Padi (5)	% of Main Season Average Yield	Rice (6)	Padi (7)	% of total	Rice (8)	
	Acres	% of total	Acres	% of (2)	Acres	% of (2)	*Gtg.*		lb.	*Gtg.* ('000s)		Tons	
Perlis	1,760	6.5	—	—	1,760	100.0	260	119.3	917	457	7.8	720	
Kedah	6,250	22.9	20	.3	6,230	99.7	237	108.7	836	1,474	25.1	2,320	20 acres damaged by wild pigs and rats.
Kelantan	6,880	25.3	20	.3	6,860	99.7	217	99.5	766	1,491	25.4	2,350	20 acres destroyed by flood.
Trengganu	4,700	17.3	170	3.6	4,530	96.4	146	67.0	515	661	11.2	1,040	170 acres damaged by flood and pests.
Penang and P. Wellesley	—	—	—	—	—	—	—	—	—	—	—	—	
Perak	2,480	9.1	—	—	2,480	100.0	154	70.6	543	383	6.5	610	
Selangor	—	—	—	—	—	—	—	—	—	—	—	—	
Pahang	5,050	18.5	—	—	5,050	100.0	279	128.0	984	1,411	24.0	2,220	
N. Sembilan	120	.4	90	75.0	30	25.0	67	30.7	236	2	—	—	90 acres not harvested due to late planting and damage by pests.
Malacca	—	—	—	—	—	—	—	—	—	—	—	—	
Johore	—	—	—	—	—	—	—	—	—	—	—	—	
Total 1959-60 Season	27,240	100	300	1.1	26,940	98.9	218	—	769	5,879	100	9,260	
Total 1958-59	22,650	—	640	2.9	22,010	97.1	207	—	730	4,562	—	7,180	

Acreage to nearest 10 acres.
Rice Production to nearest 10 tons.
Conversion Rates: 635 *gantangs* Padi = 1 ton rice.
1 *gantang* Padi = 5.6 lb. Padi.
1 *gantang* Padi = 3.528 lb. Rice (i.e. Milling recovery of 63 per cent).

FEDERATION OF MALAYA RICE STATISTICS

Summary of Acreage and Production, 1959/60 Season

TOTAL WET AND DRY PADI

State (1)	Area Planted (2)		Area Destroyed (3)		Area Harvested (4)		Production		
	Acres	% of Total	Acres	Percent of (2)	Acres	Percent of (2)	Padi (5) *Gtgs.*	% of Total	Rice (6) (tons)
Perlis	64,890	7.0	—	—	64,890	100.0	30,960	8.8	48,760
Kedah	289,360	31.1	1,060	.4	288,300	99.6	127,892	36.5	201,410
Kelantan	186,180	20.0	2,720	1.5	183,460	98.5	56,810	16.2	89,460
Trengganu	63,590	6.8	950	1.5	62,640	98.5	15,826	4.5	24,920
Penang and Province Wellesley	39,370	4.2	—	—	39,370	100.0	15,647	4.5	24,640
Perak	117,830	12.7	530	.4	117,300	99.6	50,544	11.6	63,850
Selangor	48,960	5.3	30	.1	48,930	99.9	25,432	7.2	40,050
Pahang	47,830	5.2	20	—	47,810	100.0	10,876	3.1	17,130
Negri Sembilan	31,100	3.4	590	1.9	30,510	98.1	11,402	3.2	17,960
Malacca	31,400	3.4	370	1.2	31,030	98.8	12,727	3.6	20.040
Johore	8,760	.9	80	.9	8,680	99.1	2,676	.8	4,210
Total Main Crop	929,270	100	6,350	.7	922,920	99.3	350,792	100	552,430
Off-Season Crop 1959	11,640	—	30	0.3	11,610	99.7	4,902	—	7,720
Total 1959/1960 Main and Off-Season Crops	940,910	—	6,380	.7	934,530	99.3	355,694	—	560,150
Total 1958/1959 Main and Off-Season Crops	924,230	—	42,990	4.7	881,240	95.3	281,273	—	442,950

Acreage to nearest 10 acres.
Rice Production to nearest 10 tons.
Conversion Rates: 635 *gantangs* Padi = 1 ton rice.
1 *gantang* Padi = 5.6 lb. Padi.
1 *gantang* Padi = 3.528 lb, Rice (i.e. Milling recovery of 63 per cent).

FEDERATION OF MALAYA RICE STATISTICS

Summary of Acreage and Production, 1959/60 Season

OFF SEASON PADI 1959

State (1)	Area Planted (2)		Area Destroyed (3)		Area Harvested (4)		Average Yield per Acre			Production			Remarks (9)
							Padi (5)	% of Average Yield	Rice (6)	Padi (7)	% of total	Rice (8)	
	Acres	% of total	Acres	% of (2)	Acres	% of (2)	*Gtg*		lb.	*Gtg.* ('000s)		Tons	
Perlis	—	—	—	—	—	—	—	—	—	—	—	—	
Kedah	1,125	9.7	35	3.1	1,090	96.9	543	128.1	1,916	591,480	12.1	932	35 acres damaged by pest and drought.
Kelantan	470	4.0	—	—	470	100	505	119.1	1,782	237,520	4.8	374	
Trengganu	150	1.3	—	—	150	100	285	67.2	1,005	42,800	.9	67	
Penang and P. Wellesley	9,850	84.6	—	—	9,850	100	407	96.0	1,436	4,001,900	81.8	6,318	
Perak	45	0.4	—	—	45	100	400	94.3	1,411	18,000	.4	28	
Selangor	—	—	—	—	—	—	—	—	—	—	—	—	
Pahang	—	—	—	—	—	—	—	—	—	—	—	—	
N. Sembilan	—	—	—	—	—	—	—	—	—	—	—	—	
Malacca	—	—	—	—	—	—	—	—	—	—	—	—	
Johore	—	—	—	—	—	—	—	—	—	—	—	—	
Total	11,640	100.0	35	0.3	11,605	99.7	422	—	1,489	4,901,700	100.0	7,719	
Total 1958	7,920	—	10	—	7,910	100.0	400	—	1,411	3,165,000	—	4,984	

Acreage to nearest 5 acres.
Rice Production to nearest ton.
Conversion Rates: 635 *gantangs* Padi = 1 ton rice.
1 *gantang* Padi = 5.6 lb. Padi.
1 *gantang* Padi = 3.528 lb. Rice (i.e. Milling recovery of 63 per cent).

METEOROLOGICAL SUMMARY, MALAYA, JANUARY, 1960

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of		Means of A and B	Absolute Extremes				At 4 foot	At 1 feet	Total		Most in a day	Number of Days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.		Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	° F	° F			Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
										in.	mm.	in.						hr.	hr.	
Ipoh, Perak	92.3	71.6	81.9	96.2	68.0	77.8	74.7			9.86	250.4	1.98	15	15	3	10		229.75	7.41	
Kuala Lumpur, Selangor	90.2	73.1	81.7	93.9	70.9	80.0	75.0	83.7	85.1	3.58	90.9	1.13	14	10	5	2		189.05	6.10	
Sitiawan, Perak	88.6	72.4	80.5	91.9	68.8	81.5	74.5	83.4	84.4	4.04	102.6	1.87	14	11	1	1		204.65	6.60	
Kuantan, Pahang	83.9	70.8	77.3	88.0	65.8	75.7	73.8	79.0		17.71	449.8	4.34	24	8	3	1		148.15	4.78	
Bayan Lepas, Penang	89.9	73.7	81.8	92.4	71.2	87.6	77.8			2.60	66.0	0.98	8	8	4			253.80	8.19	
Malacca	88.0	72.5	80.3	90.4	70.5	75.5	74.2			6.81	173.0	1.89	12	11	4			191.05	6.16	
Mersing, Johore	82.6	73.8	78.2	86.0	6.99	78.0	72.8			7.49	190.2	2.93	16	13			2	172.05	5.55	
Alor Star, Kedah	89.8	71.6	80.7	93.4	66.7	82.7	76.9			1.26	32.0	0.71	6	5	1			257.30	8.30	
Kota Bharu, Kelantan	84.0	73.1	78.5	86.6	70.2	79.9	77.9	81.7	82.7	7.52	191.0	5.19	15	12		1		199.40	6.43	
K. Trengganu, Trengganu	83.2	73.2	78.2	85.3	68.5	76.3	72.0			12.39	314.7	4.89	21	18				201.90	6.51	
Singapore	85.5	73.5	79.5	88.0	71.0	80.6	76.0			5.24	133.1	1.67	14	12	4			157.45	5.08	
HILL STATIONS																				
Cameron Highlands, Tanah Rata, Pahang. (3750 ft.)	71.5	54.9	64.2	75.8	47.2	63.8	62.4			7.01	178.1	2.98	14	10				181.30	5.85	

Compiled from returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, FEBRUARY, 1960

Locality	Means of		Means of A and B	Absolute Extremes				Earth Temperature		Rainfall								Bright Sunshine		
	A. Max.	B. Min.		Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total		Most in a day Amt.	Number of Days: Precipitation .01 in. or more	Precipitation .04 in. or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
										in.	mm.	in.						hr.	hr.	
Ipoh, Perak	92.9	72.6	82.7	96.1	69.4	87.0	74.9			7.01	178.1	2.23	14	10	4			203.55	7.02	
Kuala Lumpur, Selangor	90.9	73.1	82.0	94.8	70.0	82.2	76.0	84.3	85.0	2.87	72.9	1.25	10	8	6	1		196.80	6.99	
Sitiawan, Perak	88.6	72.6	80.6	91.4	70.0	82.5	75.0	82.0	82.5	11.70	297.2	2.18	17	15	8			200.20	6.90	
Kuantan, Pahang	85.1	71.1	78.1	88.2	67.1	78.0	74.3	79.7		9.36	237.7	3.43	16	14	1			170.65	5.88	
Bayan Lepas, Penang	90.0	74.1	82.1	93.3	70.2	86.3	77.8			5.67	134.0	2.32	12	10	8			222.15	7.66	
Malacca	88.7	73.1	80.9	93.1	70.9	78.2	74.8			1.04	26.4	0.39	8	7	1			187.80	6.47	
Mersing, Johore	82.6	74.3	78.5	86.0	69.0	76.4	77.6			13.74	359.0	3.97	14	11	1			167.25	5.77	
Alor Star, Kedah	92.6	72.2	82.4	95.4	69.4	89.7	75.7			0.47	11.9	0.38	4	1	1			245.45	8.46	
Kota Bharu, Kelantan	85.3	73.6	79.5	87.8	69.1	83.9	78.0	84.4	85.6	0.80	2.0	0.55	3	3		2		218.45	7.53	
K. Trengganu, Trengganu	84.1	73.2	78.7	85.7	70.0	81.3	77.5			2.24	56.9	0.80	11	8				222.60	7.67	
Singapore	86.1	73.6	79.9	89.5	71.9	79.0	75.1			8.35	212.1	1.76	12	10	5			155.15	5.35	
HILL STATION																				
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	71.5	56.7	64.1	75.2	49.2	66.8	61.4			2.00	50.8	0.56	15	10				120.75	4.16	

Compiled from returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, MARCH, 1960

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes						Total		Most in a day	Number of Days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot	At 4 feet			Amt.	Precipitation .01 in. or more	Precipitation .04 in. or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
								° F	° F	in.	mm.	in.						hr.	hr.	
Ipoh, Perak	93.9	72.9	83.4	97.8	67.4	86.7	75.9			8.83	211.6	2.19	12	11	10			242.45	7.82	
Kuala Lumpur, Selangor	92.1	73.7	82.9	95.6	69.8	83.4	76.1	84.4	85.6	12.88	327.2	2.62	18	18	17	3	2	231.00	7.45	
Sitiawan, Perak	90.4	72.7	81.5	93.5	69.9	84.0	75.8	83.9	84.7	1.04	26.4	0.48	9	7	3			236.35	7.62	
Kuantan, Pahang	89.4	69.5	79.5	94.1	62.0	84.4	73.5	83.2		1.72	43.7	0.84	8	6	3	2		241.50	7.79	
Bayan Lepas, Penang	89.9	74.1	82.0	93.6	69.0	83.0	77.4			4.93	125.2	2.13	9	17	10			257.10	8.29	
Malacca	90.3	73.3	81.8	94.1	70.9	83.2	75.0			4.28	108.7	2.07	14	9	9			221.35	7.14	
Mersing, Johore	86.8	71.9	79.3	90.7	66.9	80.2	76.4			3.15	80.0	1.25	7	5	3			247.70	7.99	
Alor Star, Kedah	93.6	72.4	83.0	96.4	67.4	89.8	77.2			7.93	201.4	2.23	13	11	7	1		279.75	9.02	
Kota Bharu, Kelantan	89.3	72.4	80.9	93.0	66.9	87.0	76.6	90.0	87.3	0.73	18.5	0.67	2	2				312.85	10.09	
K. Trengganu, Trengganu	88.3	72.3	80.3	91.6	66.0	86.0	75.3			0.62	15.7	0.25	5	3		2		264.95	8.83	
Singapore	88.5	74.2	81.3	91.6	71.8	81.4	76.6			4.87	123.7	1.29	13	13	11			208.85	6.74	
HILL STATION																				
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	73.7	53.3	63.5	76.2	46.8	69.8	60.0			9.04	229.6	1.67	21	17				160.50	5.18	

Compiled from returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, APRIL, 1960

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of		Means of A and B	Absolute Extremes				At 1 foot	At 4 feet	Total		Most in a day	Number of Days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.		Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	°F	°F			Amt.	Precipitation .01 in. or more	Precipitation .04 in. or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
										in.	mm.	in.						hr.	hr.	
Ipoh, Perak	92.7	73.7	83.2	95.2	69.1	86.8	76.0			12.25	311.2	1.82	21	20	14			205.55	6.85	
Kuala Lumpur, Selangor	90.6	74.5	82.5	93.8	72.3	82.5	76.9	84.8	85.8	6.96	176.8	1.65	19	13	15	5		173.10	5.77	
Sitiawan, Perak	89.3	73.6	81.5	92.9	69.9	84.5	76.1	84.4	85.2	4.13	104.9	0.95	19	15	10	2		192.70	6.42	
Kuantan, Pahang	89.7	72.1	80.9	94.2	69.0	84.5	74.3	83.8		8.78	223.0	1.98	16	10	11	8		183.70	6.12	
Bayan Lepas, Penang	88.5	75.0	81.7	91.2	71.2	82.7	78.0			8.61	218.7	1.68	18	16	19		1	200.50	6.67	
Malacca	89.0	73.8	81.4	92.2	70.8	81.8	76.0			4.06	103.1	1.96	13	12	11	1		160.60	5.35	
Mersing, Johore	88.1	72.4	80.3	92.4	70.9	76.4	74.0			4.71	119.6	0.96	21	4	9			189.60	6.32	
Alor Star, Kedah	91.9	74.4	83.1	95.3	71.0	85.8	78.4			6.49	164.8	1.32	19	16	6			245.95	8.20	
Kota Bharu, Kelantan	89.7	75.3	82.6	92.0	73.0	84.6	77.3	89.8	88.7	9.01	228.9	3.71	10	9	9		1	267.95	8.93	
K. Trengganu, Trengganu	89.0	73.7	81.3	92.0	71.0	78.2	76.1			5.17	131.3	1.73	9	9	4			264.95	8.83	
Singapore	87.8	75.1	81.5	91.5	73.2	80.1	77.0			4.50	114.3	0.94	16	13	14			143.55	4.79	
HILL STATION																				
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	74.4	57.1	65.7	79.8	51.8	70.8	62.8			11.79	299.5	0.95	24	23				133.45	4.45	

Compiled from returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, MAY, 1960

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of		Means of A and B	Absolute Extremes				At 1 foot	At 4 feet	Total		Most in a day	Number of Days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.		Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	° F	° F			Amt.	Precipitation .01 in. or more	Precipitation .04 in. or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
										in.	mm.	in.						hr.	hr.	
Ipoh, Perak	93.0	74.4	83.7	96.0	72.8	88.1	77.3			8.08	205.2	1.42	19	18	6			209.80	6.77	
Kuala Lumpur, Selangor	92.4	75.3	83.9	96.3	72.7	87.8	77.5	85.8	86.1	3.10	78.5	1.15	16	8	7	2		222.30	7.17	
Sitiawan, Perak	90.7	74.4	82.5	94.2	72.8	84.9	76.2	85.3	85.9	2.93	74.4	0.79	11	18	7	2		205.05	6.61	
Kuantan, Pahang	90.2	72.6	81.5	92.9	70.3	81.5	75.0	84.7		5.47	138.9	1.20	15	12	12			227.70	7.35	
Bayan Lepas, Penang	89.2	75.2	82.2	92.0	72.6	85.6	77.3			7.77	197.4	1.58	17	16	12			201.15	6.49	
Malacca	89.7	74.1	81.9	92.1	71.7	85.8	76.1			3.94	100.1	1.22	12	8	5			227.00	7.32	
Mersing, Johore	89.6	72.6	81.1	91.6	70.9	86.5	74.0			4.75	120.7	0.78	19	16	8			242.80	7.83	
Alor Star, Kedah	90.7	75.4	83.1	93.5	72.8	81.4	78.3			10.35	262.9	2.20	19	15	6			232.10	7.49	
Kota Bharu, Kelantan	90.1	75.7	82.9	92.8	73.6	85.6	77.2	88.7	89.0	2.92	74.2	1.51	10	9	7			227.00	7.32	
K. Trengganu, Trengganu	90.1	74.3	82.2	92.8	72.6	85.4	76.1			4.14	105.2	1.91	9	7	4			239.40	7.72	
Singapore	89.3	75.4	82.3	92.6	72.6	85.2	78.1			5.57	141.5	1.95	14	10	14	2		221.85	7.16	
HILL STATION																				
Cameron Highlands, Tanah Rata, Pahang, (4750 ft.)	74.9	56.9	65.9	78.2	49.4	72.0	62.2			12.29	312.2	2.94	16	15				151.00	4.87	

Compiled from returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, JUNE, 1960

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of		Means of A and B	Absolute Extremes				At 1 foot	At 4 feet	Total		Most in a day	Number of Days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.		Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	° F	° F			Amt.	Precipitation .01 in. or more	Precipitation .04 in. or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
										in.	mm.	in.						hr.	hr.	
Ipoh. Perak	91.4	73.2	82.3	95.7	69.8	84.8	75.7			3.94	100.1	0.74	11	11	6			205.00	6.83	
Kuala Lumpur, Selangor	91.8	74.0	82.9	95.8	71.8	83.7	77.2	86.3	87.0	3.98	75.7	2.86	8	7	2			214.15	7.14	
Sitiawan. Perak	90.2	73.2	81.7	94.1	70.6	80.7	75.0	84.9	86.4	5.53	140.5	2.11	4	4	2	1		212.65	7.09	
Kuantan. Pahang	90.2	72.4	81.3	92.7	70.1	86.8	76.0	84.4		3.42	86.9	0.94	11	10	9	2	1	206.00	6.87	
Bayan Lepas, Penang	88.1	74.8	81.5	90.6	70.2	82.0	78.0			5.93	150.6	1.35	11	10	8			206.90	6.90	
Malacca	87.9	73.1	80.5	90.1	70.7	83.8	75.1			8.59	—	2.64	13	10	9			187.60	6.25	
Mersing. Johore	88.7	72.5	80.6	92.2	69.8	86.6	74.4			8.55	217.2	1.55	18	17	15			194.50	6.48	
Alor Star. Kedah	89.1	75.1	82.1	93.1	71.7	80.8	78.4			9.53	242.1	2.28	14	12	7			200.00	6.67	
Kota Bharu, Kelantan	88.9	74.9	81.9	92.5	72.7	80.9	77.8	87.1	88.3	3.83	97.3	0.97	12	11	8			195.65	6.52	
K. Trengganu, Trengganu	88.1	73.6	80.9	93.0	70.9	83.3	76.6			7.41	188.2	1.52	10	9	8			190.75	6.36	
Singapore	87.9	75.6	81.7	90.1	72.5	83.1	80.2			7.20	182.9	1.79	14	14	12	1		162.40	5.41	
HILL STATION																				
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	73.4	55.8	64.6	78.8	50.2	65.2	60.8			3.04	77.2	0.72	13	12				152.25	5.07	

Compiled from returns supplied by the Malayan Meteorological Service.

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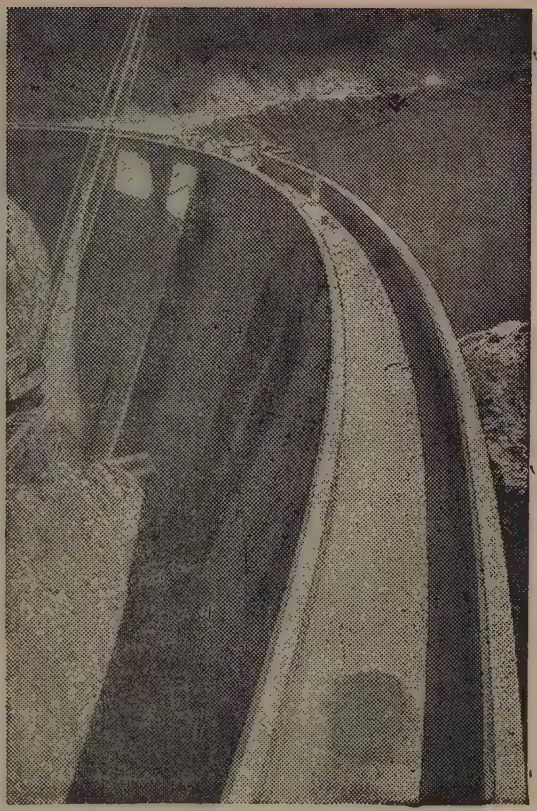

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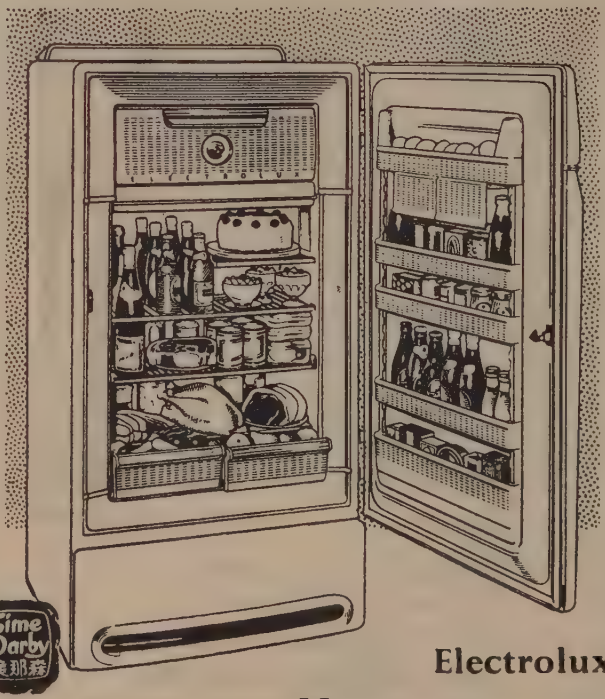

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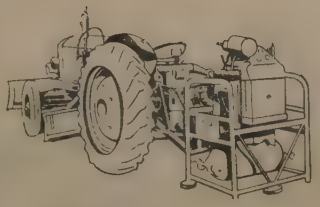

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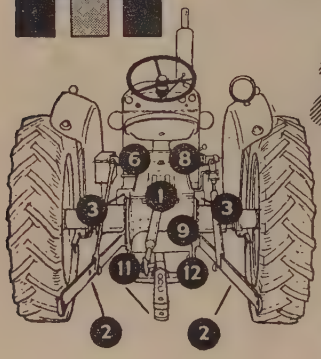

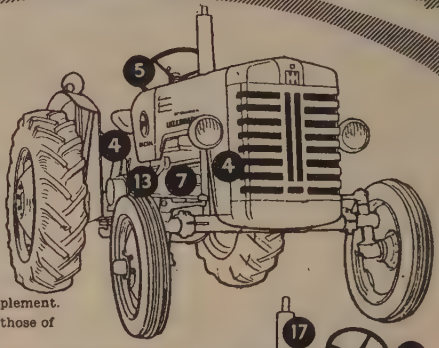

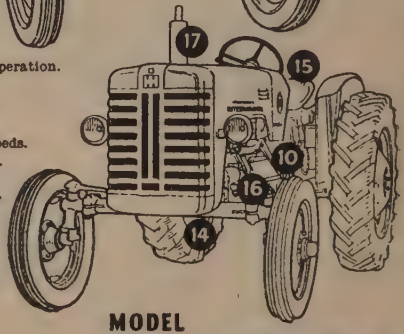

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